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VOLUME X
Number 2

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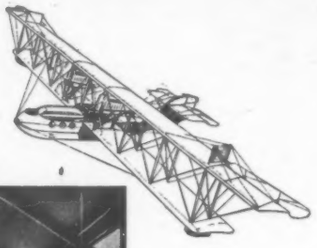

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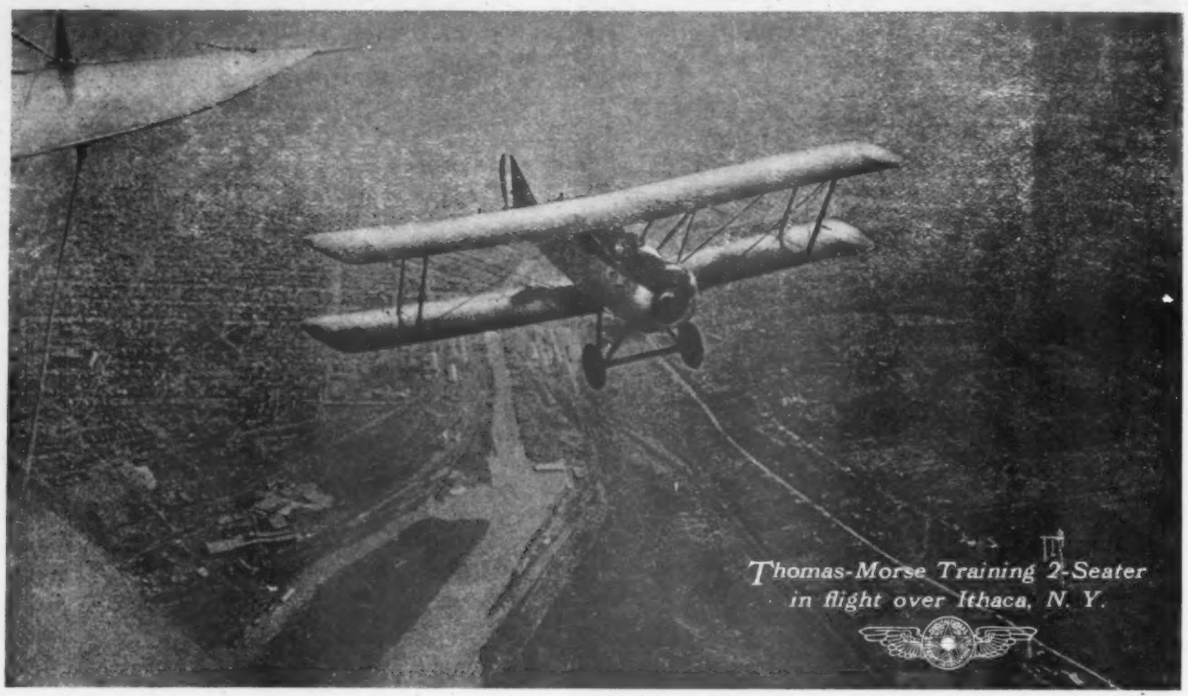

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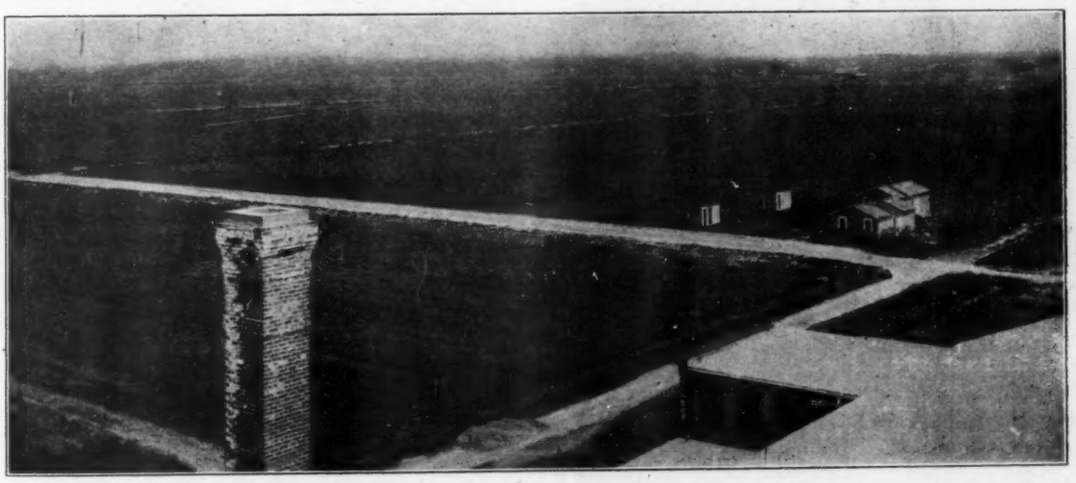

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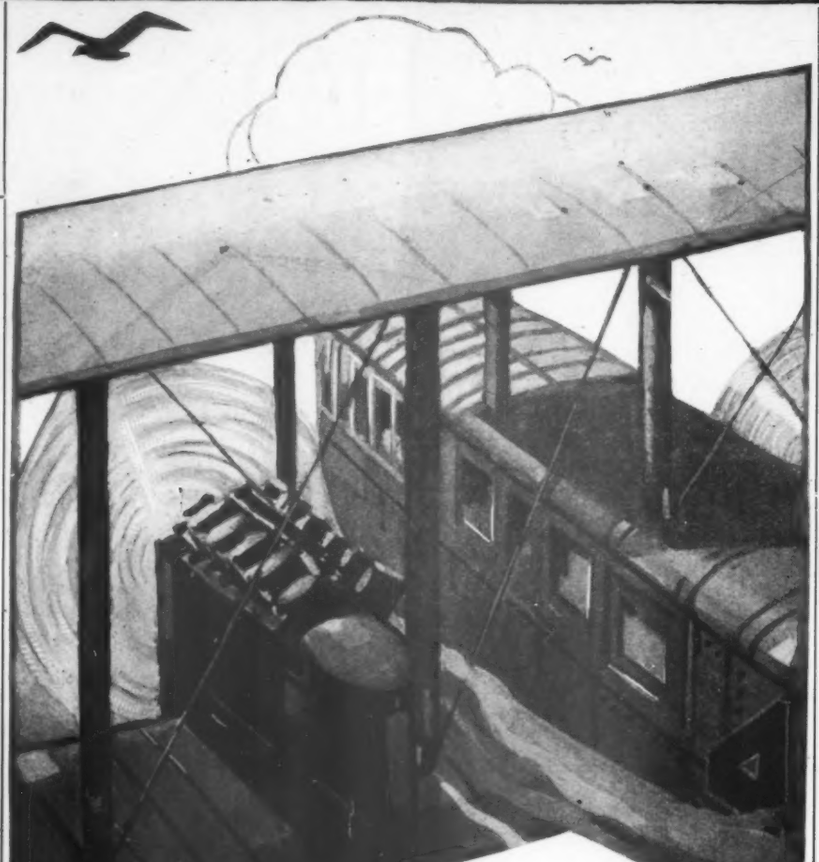

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Aerial Lighthouses

THE Post Office Department is planning to place a series of lights between Chicago and Cheyenne and inaugurate night flying between these points. This will be the first use of these devices in this country for that purpose and the experience gained will be of great value to American aviation.

Foreign countries have devoted considerable thought and money to the development of aerial lighthouses. The London-Paris airway is to be equipped with them in the near future. A point brought out by this foreign work is that the industry for the building of these lights already exists in the light house business.

Light houses have been used for centuries in maritime transportation to indicate dangerous localities and the entrances of harbors. They have usually been maintained by the various governments and have reached a very high degree of perfection and reliability. This accumulated experience will be of great value to aviation because it will elminate a great deal of experimentation as the principal difference lies in the character of the beam. Light houses for aeronautical use indicate a course, a purpose maritime beacons seldom fulfill.

This dual function in aviation will probably result in two types of lights being developed. One, a large light for use at air ports and the other an automatic or semi-automatic light for marking emergency landing fields and incidentally the course. The first type will very likely be similar to the large lighthouses now employed with the difference that the beam will be broader and directed upwards. The smaller type will be very similar to the type now employed on signal buoys. Lights have been developed that are entirely automatic in their action and do not require attention more than once a year. Development along these lines will be watched during the coming year with the greatest interest.

Uncertainty in Wing Design.

FOR quite a number of years the girder type of biplane was supreme in almost all types of machines, irrespective of size or service. At the present moment, designers are experimenting with internally braced wings, girder type of biplane construction with long unsupported spans, monoplanes with rigid bracing, internally braced monoplanes with struts at the body to relieve the cantilever load and a number of other combinations.

Each type of construction seems to have its own advantages and defects. The girder type biplane certainly suffers from the disadvantages of wing interference and resistance of the interplane bracing. The internally braced monoplane is extremely clean, but in spans running to any length at all, it is liable to be very heavy. It is possible that the best compromise will finally be achieved in the way of internally braced monoplanes with auxiliary trussing to relieve the heavy loads and lighten the weight per square foot of the wing structure.

Aeronauts Safe.

WHEN the news came from Canada that the three lost Navy aeronauts had landed safely and were coming out of the Hudson Bay woods, there was general rejoicing from all parts of the country. Only when such happenings occur, is it realized that the public takes such an emotional interest in the welfare of our daring pilots.

Officers in service of the government can do the regular work required of them for years and no notice is taken of it, but let them try some flight that has in it an effort to excel previous achievements or an attempt to explore the unknown and their efforts are watched from coast to coast.

The flight of the Navy balloon in mid-winter toward the inaccessable regions of Canada was a daring exploit and one that many who know the perils of such an adventure might criticize. But it will again let the public know that our officers are ready to sail away into the night on experimental trips and not come down until they had reached the goal of their journey.

Fatigue and Duralumin.

ONE of the most important points in connection with the use of duralumin for airplane construction is the question of fatigue. Duralumin has been successfully used for many years in dirigible construction and apparently no difficulties have been experienced from the point of vibration and fatigue. Dirigibles however seldom have to meet the sudden and alternating stresses which an airplane has to undergo. Also in dirigible construction sections employed have generally been larger than would be the case in airplanes of moderate size.

Dirigible evidence as regards the resistance to fatigue of duralumin is therefore not entirely conclusive. Duralumin strips bent through 180 degrees in the classical manner of such tests do not show up as well as steel strips tested in the same way. Duralumin forgings on the other hand, have shown up better in fatigue tests than steel forgings. In neither case were the tests exhaustive and the evidence from these two lines of experimentation is somewhat conflicting. It would seem highly advisable at the present moment to undertake a systematic investigation as to the fatigue properties of duralumin.

Gasoline Systems.

WHILE the attention of designers has been centered on perfecting gasoline systems for many years, there still seems too much complexity in the design of such systems. Recently a gasoline system of a well known machine was responsible for two serious accidents. The system involved a main tank, gravity feed and an overflow return. While as simple as this type of system could be, it was complicated enough to cause trouble. By making the overflow return to the inlet side of the pump, removing the gravity tank and applying a hand pump, it is understood that more than fifty per cent of the lines and connections were removed, and much more satisfactory results were achieved.

Value of Model Tests

By J. W. Margoulis

Former Director of the Eiffel Laboratory

The results given by aerodynamical laboratories have certainly rendered the greatest service to aviation by enabling the magnitude of the forces sustained by an airplane and its organs to be obtained with fair precision.

It is considered, however, that the precision of the information given on the conditions of flight of full-scale machines is no longer sufficient, and that at present there is urgently required on the one hand, a program of comparison and revision and, on the other hand, scientific experimentation, if it is to contribute usefully to the progress of aviation, must undertake more comprehensive and far-reaching tests than those hitherto realized.

The influence on the exactness of results given by laboratory tests of the internal structure of the air-stream realized, will be examined first, then the influence of the ratio of the dimensions of the model to those of the airstream and finally the influence of the ratio of these same dimensions and of the speed of the air-stream to the dimensions and speed of the full scale machine. We shall also indicate what the aerodynamic laboratory may possibly be in the future.

Internal Structure of the Airstream of Wind Tunnels

When we compare the results of tests on the same models obtained in different laboratories, it is seen that very often these results do not agree; a few particularly striking examples of this fact are given:

1—The results of the airfoil tests of the N.P.L. systematically give better polars than those obtained in the Eiffel Laboratory.

Having noticed this fact, the Eiffel Laboratory tested wings having a profile R.A.F. 14, 15, and 16, of dimensions 90 x 15 cm. at speeds of 12 and 25 m./sec.; the N.P.L. tests of these wings had been made as usual on models of 45.7 x 7.6 cm. at a speed of 12 m./sec.

A comparison of the polars showed that those of the N.P.L. are better, not only with respect to the Eiffel laboratory polars obtained at 12 m./sec., that is, for a product VL twice as large, but also with respect to those obtained at 25 m./sec., corresponding to VL four times as large. During the war, this had a very important practical consequence for airplane constructors to whom the S.T.Ae. communicated the tests on airfoils made in the two laboratories, concluded that the profiles tested in the N.P.L. were the better, while in reality, the difference arose either from errors in measurement, or in the determination of speeds in one or the other of these laboratories.

2.—The Goettingen laboratory, comparing its results for tests of spheres with those obtained at the Eiffel laboratory and at the St. Cyr laboratory, (the latter being conducted in a blower-tunnel), found that for certain values of VL the coefficients obtained were much greater than those of the Eiffel and St. Cyr laboratories.

The Goettingen laboratory believes that this difference arises from the internal structure of the air-stream, which is turbulent in the Eiffel and St. Cyr laboratories and non-turbulent at Goettingent. As a matter of fact, they say, if in their wind-tunnel they place a wire-netting before the sphere, thus making the air-stream turbulent, they note immediately that the coefficient of resistance decreases and approaches that obtained at the Eiffel and St. Cyr laboratories.

The difference between the internal structure of the fluid filaments in different wind-tunnels is perhaps due to the following reason deduced from a statement made by Dr. Prandtl and which leads to the assumption that the mode of air-flow in a tunnel with open circuit is not the same as that in a tunnel with closed circuit.

According to this statement, there is formed on the walls of a flue with open circuit a zone of vortices whose number increases with distance from the entrance of the flue, and it is only at a certain distance from the entrance of the flue that the whole of the air-stream becomes a mass of vortices and that the flow is similar to that of the air in a long tube.

But under these conditions we arrive at the conclusion that the air-stream in a closed circuit flue is vortical all along the flue, while in a wind-tunnel with open circuit in which the working section is near the entrance of the collector and in which the honeycomb is suppressed, the air-stream in the working section would not be vortical.

We may remark that this conclusion is in formal contradiction to the opinion of the Goettingen laboratory given above on the turbulence of the stream-lines in the open circuit wind-tunnel of the Eiffel laboratory and in their own closed circuit wind-tunnel.

In any case, the disagreement of test results may arise not only from errors of experiment, but, what is much more serious, from the very mode of air-flow and those who believed that the principle of relativily was not, a priori, applicable to tests in an air-stream were not altogether wrong, since it is possible to obtain, not only in different wind-tunnels, but even in the same wind-tunnel, different modes of air-flow and since it is perhaps one only of these modes, or perhaps none of them, that gives the same results as those obtained with a body moving in motionless air.

On the other hand, whatever be the mode of air-flow, in wind-tunnels with continuous walls pressure drop may occur along the air-stream, due to the friction of the air on the walls and to the acceleration of the air necessitating correction of results which are particularly appreciable as regards the resistance of stream-line bodies of rather extensive dimensions, measured parallel to the axis of the air-stream.

Thus, in certain cases the measured resistance of a model dirigible is 20 per cent greater than the true resistance.

Pressure drop may be avoided in wind-tunnels with continuous walls by widening the section of the flue as was done by Dr. Prandtl in the first wind-tunnel with closed circuit at Goettingen.

In flues with interrupted walls the phenomena are different and we find a speed drop along the axis of the stream. These corrections are not yet regularly employed by all laboratories, for some do not agree with their advisability, and others have not yet heard of them.

Because of these serious discrepancies between different laboratories it would seem very important that laboratory staffs should follow each other's work much more closely.

Influence of the Relative Dimensions of the Air-stream of the Models

It has just been shown that the want of precision in forecasting full scale results from model tests arises in the first place from the mode of air-flow in the wind-tunnel and that the laboratories are not yet agreed as to the legitimacy of the methods proposed for the correction of results in certain cases.

But besides these corrections, Dr. Prandtl has lately proposed others which are to take into account the disturbance introduced by the presence of model wings in an air-stream of limited dimensions. Thus for a single wing placed in a wind-tunnel of circular section, the author finds that the measured coefficient of induced resistance is:

$$K'_{xi} = K_{xi}\left(1 + \frac{b^2}{8R^2}\right)$$

where K_{xi} is the true coefficient of induced resistance, b, the span of the wing, and R the radius of the section of the air-stream. The term $b^2/8R^2$ is positive or negative according to whether the walls of the flue are interrupted or continuous at the place of the working section.

For $b/R = 1$ (a usual case in laboratories), the difference between true and measured induced resistance reaches ⅛ of the true resistance and the measured resistance in a flue with free stream would be 43 per cent greater than the resistance measured in a wind-tunnel with continuous walls.

Influence of the Ratio of the Dimensions of the Model and Speed of the Test to the Dimensions of the Full Scale Machine and Its Speed of Flight

In the early days of aviation, the laws of similitude generally employed in passing from model tests to full scale machines were the law of proportionality of the square of the speed and of the square of linear dimensions. No notice was taken of the relative values of the dimensions of the model and of the speed of the test with respect to the dimensions of the airplane and to its flying speed.

Applied indiscriminately as they were, and in view of the small dimensions of the first wind-tunnels and the low speed

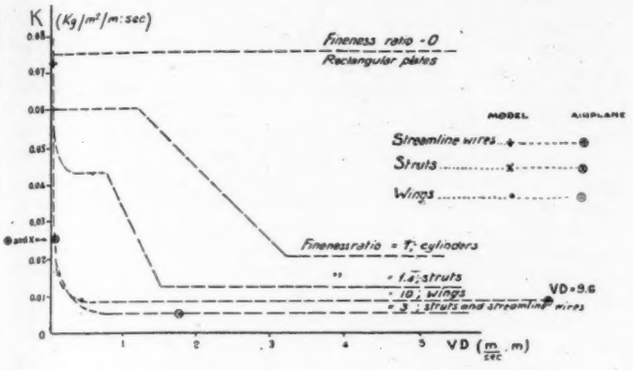


FIG. 1. COEFFICIENT OF RESISTANCE OF THE STRUTS IN TERMS OF FINENESS RATIO AND OF REYNOLDS' NUMBER

of the air-streams, these laws many times led to results totally different from full scale results.

Thus, great progress was made when it was perceived that, if the coefficients of resistance often vary as a function of the speed and dimensions of the model, they may nevertheless be considered as functions of *Reynold's number* that is of the product of the speed of the test and the principal dimensions of the model divided by the kinematic coefficient of viscosity.

When we consider the principal organs of an airplane, we see that they may be divided into two classes, according to their shape. To the first group belong the bodies obtained by the translation of a section; such are the wires and struts of the wing truss and landing gear and the wings of small incidences. To the second group belong the bodies of revolution, that is, fuselages, hulls, etc. which may be designated under the general name of stream-line bodies.

As regards struts, a general table of their aerodynamic characteristics may be drawn up as follows: Let a be the fineness ratio of the section, that is, the ratio of depth to thickness D and VD the product of the speed V in m./sec and the thickness D in m. If in each fineness ratio a curve is plotted of the coefficient of resistance K in the function VD, the diagram, Fig. 1, drawn up according to the experiments of the Eiffel Laboratory, is obtained.

In this figure a cross indicates the value of the coefficient corresponding to the value of VD realized in the 1/10 scale model of a pursuit plane with a span of 10 m. at a speed of 25 m./sec. These same values for the full scale airplane in horizontal flight near the ground at 60 m./sec. are marked by a circle. For the streamline wires the values pass from about $K = 0.05$ for the model to $K = 0.025$ for the airplane; that for the wing struts and landing gear pass from 0.025 to 0.005, but for the wings the coefficient remains constant.

Accordingly from 1915 at the Eiffel laboratory testing airplane models with the wires, radiators, and machine-gun turrets, that is, with organs the resistance of which could be determined for full scale, was abandoned and from 1917 constructors who asked for tests of complete airplanes were advised to adopt corrections due to the struts and which could be easily calculated. It was considered that the dimensions of the fuselage and airfoil were sufficient and that there was no need to apply corrections, and those which should have applied to the controls might be safely neglected.

At the present time, if it is desired to make a proper test of a model airplane, a model comprising only the wings and the fuselage must be tested. It is thus assumed that the sum of of the resistances and lifts of airplane organs tested separately may be taken. Such, in fact, is the decided opinion of the Sub-Committee appointed by the British Advisory Committee for Aeronautics for the purpose of studying the question of the accuracy of model tests. Recent experiments at the Eiffel laboratory do not always confirm this opinion.

In any case, in the tests of present day laboratories it is impossible to take into account the interactions of the various parts of an airplane.

There exist very few precise comparisons of results of model tests and of full scale tests, first, because in model tests the corrections indicated above are not usually allowed for, and also because the resistance of an airplane is not defined with sufficient accuracy, for want of thrust dynamometers.

The results acquired to date, however, warrant the conclusion that, for high lift values, laboratory results are really lower than the results given by full scale airplanes.

Therefore, larger wind-tunnels should be made, but then the objection is met of the greater cost of models, not only because of their increased dimensions, but also on account of the care required in working out their details, especially if the wash of the propeller, a question of the greatest importance at the present time, is taken into account.

Under these circumstances there is only one course to take, and that is to create an installation where full scale airplanes can be tested, that is, a wind-tunnel with a diameter of 5 or 6 m. a speed of 60 m./sec. and from 1200 to 1500 hp.

Very great importance is not attached to the speed nor is it necessary to realize in such a laboratory the speeds of 300 km./hr. which will shortly be reached by airplanes. A special device, reducing the section of the working section, should however, make it possible to exceed even that speed.

The aim of this laboratory should not be to make rapid and inexpensive tests of small models with a view to obtaining an approximate forecast of the results to be expected from a new airplane. For such work as this the present laboratories suffice. The aim of the large laboratory which we suggest would consist in accurately determining the forces sustained by existing airplanes of medium size, taking into account all the conditions of real flight. The exact determination of forces would obviously lead, by comparison of the various solutions already realized, to a systematic improvement of airplanes.

As a matter of fact, it often happens that similar airplanes give very different results, without our knowing what causes the superiority of one plane over the other. As an example of this may be mentioned the tests carried out during the war by the French S.T.Ae. on the Haviland DeH-4, with the Rolls-Royce 300 hp. engine, and the Breguet 14-A.2, with the Renault 300 hp. engine.

The former gave better results though it was impossible to say to what such superiority was due. In order to eliminate the engine question, a Renault engine was fitted on a DeH-4.

It is evident that an installation of such power can only be built and kept up by the State, but the services rendered would be of such inestimable value that there would never be occasion to regret the outlay. It would allow of full scale tests of propellers, airplane fuselages with landing chassis, and of parts of the wing sufficiently large to determine the interaction of the wing and the fuselage. By means of Prandtl's method (test between vertical walls) results would be obtained corresponding to those of full scale wings. The fuselages would be tested with engines running, which would bring out the very great and hitherto neglected influence of the wash of the propeller on the resistance and lift of the airplane, as well as on the action of the controls. The influence of the location of the radiator would no longer be suppressed, but would be exactly measured, taking into account also the wash of the propeller.

Forces on the machines would be measured by a balance, propeller tests would be made by means of dynamometers.

An identical hub fitted on the same airplane would give the results of flying tests, thus affording an immediate and definite comparison of the two methods, a comparison which might be completed by that of the measurement of pressures in the laboratory and during flight.

It might be added that it is thought that if a wind-tunnel is adopted with open circuit, continuous walls in the working sec-

tion, and working by suction from free air and if the honeycomb at the entrance is developed as little as possible, the same results will be found by the two methods.

Conclusions

Present day laboratories should make their air-stream of one uniform model and should agree as to eventual corrections due to the internal structure of this air-stream and to its relative dimensions with respect to the dimensions of the models. They should, by systematic comparisons with flying tests, endeavor to find rules for the design and tests of models, as well as the laws of similitude enabling them to define accurately the conditions of flight of a full scale airplane.

It is not thought that they can do this with the actual dimensions of their wind-tunnels. Therefore the construction of a wind-tunnel with a diameter of 5 or 6 m. is suggested; a speed of 60 m./sec. and a horsepower of 1200 to 1500. Such a tunnel would allow of full scale tests of the principal organs of the airplane and of a direct comparison of these tests with flying tests.

For this purpose laboratory tests alone are not sufficient; besides them, the creation of measuring instruments, the establishment of methods of experimentation, and the carrying out of numerous flying tests are urgently needed.

The following program should be worthy of study:

1.—Standardization of tests—comparison of results obtained up to date by different laboratories on the same models; new comparative tests to be made; standardization of test conditions.

2.—Standardization of coefficients and notations. Standard atmosphere.

3.—Standardization of graphical representations of results.

4.—Standard system of bibliography.

According to the suggestions of the N.P.L. and of the St. Cyr and Goettingen laboratories, these tests would be as follows:

1.—Determination of Kx, Ky and of the centers of thrust on a wing.

2.—Tests of a complete model airplane comprising the complete determination of forces and moments and also of the more important stability derivatives

3.—Tests of a sphere and a cylinder, which allow of noting the degree of turbulence of the air-stream.

4.—Tests of stream-line body.

5.—Measurement of the uniformity of the air-stream in time.

The tests on the wing and stream-line body would be made on a standard model to be transmitted to all the laboratories and on a model made by each laboratory from a drawing. The tests of the model airplane would be made with the same model in all the laboratories.

It is believed that these tests should be preceded by the standardization of the same Pitot tube by all the laboratories concerned, and completed by propeller tests.

Aviation in the Argentine

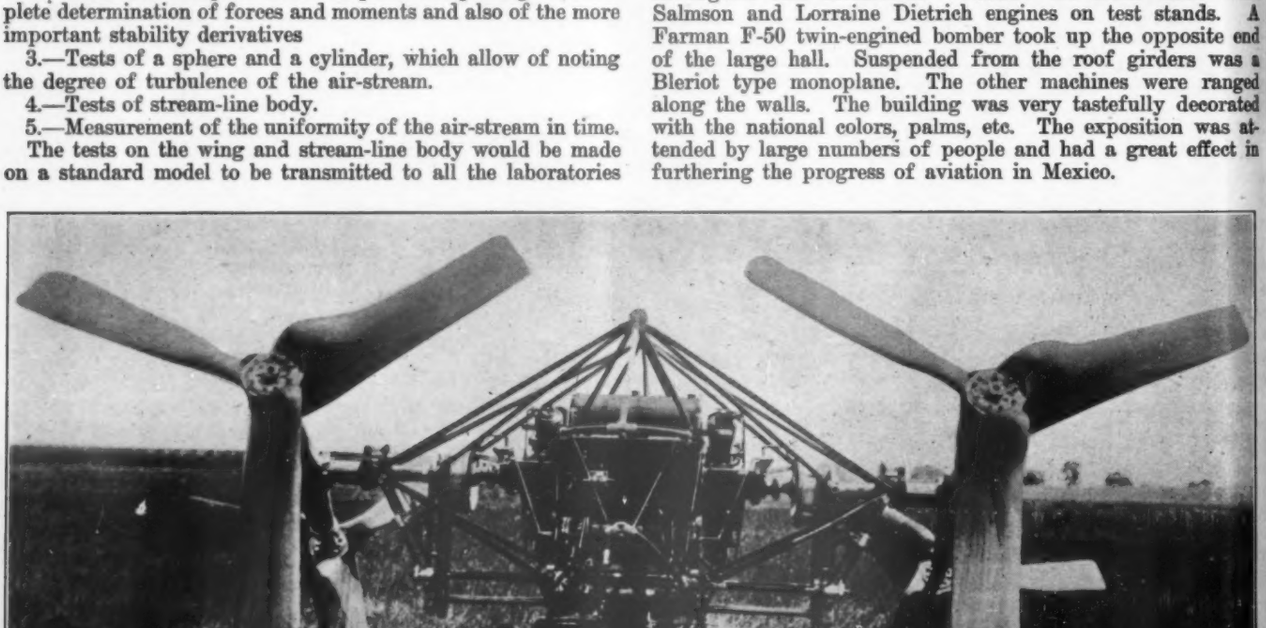
According to advices received by Handley Page, Ltd., the Argentine government has sanctioned the establishment of an important air mail service between Bahia Blanca and Rio Gallegos, the distance to be covered being about 1,500 miles. Four main aerodromes are being established at Bahia Blanca, San Antonio Oeste, Trelew, Comodoro Rivadavia with intermediate landing places at Patagones.

Two emergency landing places have been arranged for, one between San Antonio and Trelew, the other between Trelew and Comodoro Rivadavia. The headquarters of the air services will be situated at Trelew, in the vicinity of Puerto Madrin, which is the most convenient port for the transport of material. Fully equipped repair shops will be erected at all the main aerodromes and emergency outfits will be available in connection with the landing grounds.

Much enthusiasm in the Argentine has been shown in aviation since the demonstration school at El Palomar was established by Handley Page, Ltd., in December, 1919. Many pilots have been trained there for Government service as well as private owners who have purchased airplanes for the establishment of local services. A popular feature of the school has been the periodical demonstrations which have taken place there and also the many excursion flights.

Mexican Aero Show

The National Mexican Aerial Exposition was held at the Mexican Aircraft Factory, Mexico City. The exhibition contained both foreign and domestic types of airplanes as well as engines and accessories. Outside the main door were Salmson and Lorraine Dietrich engines on test stands. A Farman F-50 twin-engined bomber took up the opposite end of the large hall. Suspended from the roof girders was a Bleriot type monoplane. The other machines were ranged along the walls. The building was very tastefully decorated with the national colors, palms, etc. The exposition was attended by large numbers of people and had a great effect in furthering the progress of aviation in Mexico.



THE HELICOPTER CONSTRUCTED BY LEINWERER OF CHICAGO

Photo Underwood & Underwood

Understood to have made "successful" trials.

Goggle Requirements

While a number of good goggles have been manufactured, there is still much room for improvement. Unfortunately, some goggles that are distinctly dangerous have been put in circulation; they lessen visual acuity; create an irregular astigmatism; limit the field of vision; finally certain tints used in the lenses seriously alter the color values of objects necessary for following the topography of the ground or recognizing certain changing meteorological conditions. A very successful British pilot early in the war said in regard to an issued goggle: "They would be certain death overseas." McCudden, the famous British flier, writes: "I am a 'stickler' for details * * *. It may sound absurd, but such a thing as having dirty goggles makes all the difference between getting or not getting the Hun."

Among the 100 American pilots from the front selected for conference, 86 were dependent upon goggles in flying, six used them only occasionally and eight did not wear them at all. It is reported that several of the most famous British aces did not use any protection for the eyes in flying. The flier was not always inclined toward the wearing of goggles, chiefly because the average goggle did limit materially the extent of the visual fields, and a feeling of diminished visual acuity was the result.

The British triplex and the goggles provided for our fliers early in the war did limit the visual fields to a marked extent. In taking the perimetric readings with and without the average goggles with the eyes in the primary position, it was usually found that the goggles restricted the field of vision about 20 per cent in all meridians. Although the head is capable of much twisting in order to see in all directions, no goggle should be permitted if it restricts vision in any way. One type of goggle used by many of the allied fliers gave an almost perfect field of vision, but the projecting metal edges were dangerous because they were not rolled or padded.

Other types of eye protectors devised by different manufacturing firms in the United States gave good temporal fields, but the large size of the lenses made it very difficult to grind the correction required by a refraction error. Goggles protect the eyes from dust, water and oil, from flying insects and the drying effects of wind and the injurious exposures to cold. The vision when goggles are worn is better than any that can be obtained by partially closing the eyes.

Lenses of a yellow-green tint (which absorbs the light of short wave lengths) are valuable in the prevention of ocular and nervous fatigue. This tint allows the maximum visual acuity and does not seriously disturb useful color values. It is especially effective in bright sunshine and in flying over snow and water or above clouds. It improves vision in mist and haze, and in detecting camouflage that is produced by means of various pigments. But this tint should not be of such an optical nature that all of the blue spectral light would be absorbed. For in that case certain color values would be altered too radically.

Fliers object to lenses that are deeply smoked or of certain tints because, in addition to other disadvantages, they increase the difficulty in recognizing uniforms and in selecting the proper ground for a forced landing. Some of the pilots who had flown at the front used tinted lenses, but they usally carried in addition a pair of goggles with colorless lenses.

Zade constructed a lens which eliminated many of the disadvantages of the ordinary colored glass and permitted adaptation to marked changes in intensity of light. The lens was colorless below, gradually blending into yellow and finally into dark smoke gray above. By a slight movement of the head the appropriate portion of the lens could be used.

Halben feels that the monocle possesses certain advantages in all types of flying. But we have had no experience with this type of glass.

By the use of some nonshatterable substance, such as mica or a piece of celluloid placed either in front, behind, or between two pieces of glass, a great deal has been done to protect the eyes from breaking glass. Mica cracks and breaks readily and culluloid usually deteriorates with age, becoming yellow and less transparent. If the glass is on the posterior surface of the celluloid, small chips can break off and fly into the eye, no matter by what process the adhesion is produced. Even with this defect, however, the piece of celluloid may occasionally prevent the driving of large pieces of glass into the eye.

The danger from broken glass has been overrated. For in two years' experience in flying fields, in this country and abroad, we have never seen a penetrating wound of the eyeball by glass except in one instance. But the general injuries in this case were so serious that the man died on the day after the accident. The number of eye injuries from bad landings have been reduced by cutting a portion of the rim of the cockpit, by proper pneumatic padding of rigid places, by changing the dangerous metal rim of the wind shield, and by using goggles with well-rounded, protected edges that lie flat against the face. As the danger from breaking glass is relatively so slight, the safety afforded by a protective layer of some non-shatterable material seems hardly necessary even when applied to the posterior surface of the lens, a method sometimes used.

In regard to industrial accidents, good optical glass is in itself a protection rather than a danger to the eye; for in 30,000 of these accidents where protecting lenses have been shattered, the eyeball was penetrated in only one instance. However, the force with which the goggles are struck in airplane accidents would make penetrating wounds more common in aviation. We agree with most of the pilots with whom we have spoken on this subject, that in case of trouble or in landing on rough ground, the goggles should be pushed well up on the forehead.

Although our manual has already mentioned the qualities that the ideal goggle should possess, a brief outline at this point seems wise in order to emphasize the importance of their future development.

Material. The material must be noninflammable. So far, glass is the best material, though the future may produce something more suitable. The glass should be a good optical glass, not hardened under tension. It should be carefully ground and not less than 2 mm. in thickness. White glass should have a light transmission of more than 90 per cent.

Visual Fields. The goggles of the future should not limit the monocular or binocular fields.

The Central Blind Angle. In the construction of goggles, it is very imporant to eliminate the blind angle. This may be accomplished by using a very narrow central hinge or by connecting the lenses by a horizontal strip of metal curved in such a manner that it arches upward well over the bridge of the nose. It is therefore entirely out of the line of vision. These features appear in a new model of goggles. This model has been cut down so as to give an almost perfect visual field, and the dangerous edges rolled and protected. Even a small central bar may interfere with binocular vision when the pilot's head is turned to the side as it is in landing. We agree with Maj. Clements, R. A. M. C., that the presence of a broad central bar accounts for many errors in judgment of distance in flying and in landing.

Lightness, Strength and Comfort. Goggles should be simply yet strongly constructed. They should be light in order to be comfortable. They should not press upon the bridge of the nose and the frame should be easily and quickly adjustable to the face. They should be arranged so as to permit easy removal with one hand.

Protection of Eye and Surrounding Structures from Injury. All parts of the goggle coming in contact with the brow, nose, and cheeks should be flat against the face. All edges should be rounded and protected by some pliable material.

Adjustable Interpupillary Distance. Adjustable interpupillary distance is most important in goggles, especially when a refraction error has to be corrected. In spite of the very strict visual requirements for entrance into our service, it was necessary to prescribe correcting lenses in seven cases during our first month at Issoudun.

Lenses Quickly and Easily Changed. Some method should be devised whereby lenses could be quickly and easily removed

* From Aviation Medicine in The A. E. F., Department of Opthalmology, by Col. W. H. Wilmer and Major Conrad Berens, Jr.

for cleaning, or for replacement when new lenses are needed. The box which carries the goggles should have small compartments for holding extra sets of lenses. Everything about the goggles should be vermin proof.

Protection of Sinuses. Sufficient covering should be connected with the goggles, or supplied in such a way that it might be quickly fitted to the goggles in order to protect the sinuses from the cold. The cold of high altitudes causes great pain in the frontal regions.

Ventilation. Some indirect method of ventilating is most important to prevent steaming on the ground and frosting at high altitudes. The heat and moisture from the face will cause fogging rapidly unless there is a properly constructed ventilating system to carry the outside air to the posterior surface of the lenses. In this connection, Maj. Schroeder's account of his altitude record flight is very interesting: "While still climbing in large circles, my goggles became frosted. The temperature at this altitude (he was then more than 16,000 feet) was 2° below zero C. * * *. I believe that if my goggles had been better ventilated, they would not have frosted * * *. When I was about 27,000 feet I had to remove my goggles. The cold raw air made my eyes water, and I was compelled to fly with my head well down inside the cockpit."

Frosting. Some chemical substance should be more perfectly developed for applying to the lenses before flight in order to prevent frosting. The following words of Maj. Schroeder are very suggestive: "I gazed about through the small portion of my goggles which had no frost—due to a drop of oil which had splashed on them from the motor."

Tint. When a tint is required, it should allow the maximum vision, be restful to the eye, and not alter color values seriously.

Future Construction. The question of supplying the aviator with a well-constructed goggle and with properly ground lenses (where necessary) for constant wear in flying is an important one and our experience in France demonstrated how inadequate the facilities were for providing proper goggles and lenses.

In order that the best goggle may be obtained, the whole matter should be placed in the hands of a committee composed of an experienced flier, an ophthalmologist, a physicist, and a skillful goggle maker. This committee should draw up the specifications, pass upon the samples presented, and they should have power to accept, or to reject if necessary, the finished product.

During the rush of war this plan was not feasible. But the great future of military and commercial aviation calls for a thoroughly efficient goggle which, so far, has not been produced. Now is the time for carrying out this plan—while the shortcomings of the present goggles are still vividly in mind.

Weather Bureau Air Activities

The report of the Chief of the Weather Bureau for the fiscal year contains much material of interest to aviators. Some of the special service rendered to the Air Services are given particular attention.

Army and Navy Balloon Race.—This race was confined to officers of the Army and Navy, three balloons being entered from each of these branches of the service. It was scheduled to start at 6 p. m. September 25, 1919, and complete arrangements were made to furnish not only forecasts of surface and upper-air conditions that would be encountered, but also weather observations taken at the surface and aloft. Temporary headquarters were located at the starting grounds and telegraphic and telephonic communication established directly with the St. Louis office of the Weather Bureau. Each contestant was supplied with the observations, forecasts, and advices without delay. The information furnished was of pronounced value and the forecasts were accurate to a remarkable degree.

Recruiting Tour of Navy Seaplane NC-4.—The naval flying boat *NC-4* began its recruiting trip from Rockaway Beach, Long Island, the latter part of September, the first part being a return trip to Atlantic City, thence to Portland, Me., from which place the route extended down the coast to the Florida straits, thence over the Gulf of Mexico to Pensacola and New Orleans, up the Mississippi and Ohio rivers as far as St. Louis and Cincinnati, back again to the Gulf, and westward to Galveston. During this cruise, which covered several months, the Weather Bureau furnished a. m. and p. m. forecasts of weather and wind directions and velocities, both at the surface and aloft, for the aviation zone in which the boat happened to be at the time.

National Balloon Race.—This race was scheduled to start from St. Louis, Mo., at 6 p. m. October 1, 1919. A special message was sent that morning stating that there would be showers and thunderstorms to the east and north of St. Louis that night and the following day, and that the conditions would not be favorable for free ballooning. A second forecast, based on special observations, was sent at 2.33 p. m. advising that the race be postponed, as the balloons would be carried northward toward the Great Lakes, where squalls and thunderstorms would be experienced. Notwithstanding this advice, the race was started at the appointed time. The contestants, 10 in number, were carried northward as predicted, and squalls, thunderstorms, and generally unfavorable weather occurred. One of the balloons, with its two occupants, was lost in Lake Huron.

Transcontinental Reliability Airplane Race.—This race was confined to aviators of the United States Army. Starting points were San Francisco, Calif. ,and Mineola, N. Y., the course being a round trip between the two points. It began October 7 and ended October 31, 1919. Special forecasts were prepared for the benefit of the contestants each morning and evening during the entire period. For this purpose the route was divided into seven zones, and a separate prediction of weather that would be encountered was issued for each zone and telegraphed to the control stations. These forecasts were of great assistance to the fliers. The race was won by Lieut. Belvin W. Maynard. In commenting on the race the official news bulletin of the Air Service said:

Lieut. Maynard's wonderful time was due to the fact that he took advantage of the splendid service rendered by the Weather Bureau in sending the weather forecasts to all of the control stops. If he had been informed that the weather would be bad for the next control stop, he would immediately take off and get to this stop before the storm had approached. This enabled him to gain a distinct advantage over the other participants at the very outset of the race.

Flying-Weather Forecasts.—A new form of forecasts, known as "Flying Weather," was begun in July, 1919, at the request of the War Department, for the especial benefit of the Air Service of the Army. The country was divided into 7 zones, and a separate forecast made for each of them in the a. m., and certain of the eastern zones in the p. m. Later the number of zones was increased to 13. These forecasts are telegraphed directly to the Air Service, which distributes them to the air fields. A typical forecast, which will explain their character, is as follows:

Zones Nos. 1 and 2: Poor flying weather today; local thundershowers probable; moderate to fresh south and southwest surface winds, becoming west and moderately strong above 3,000 feet.

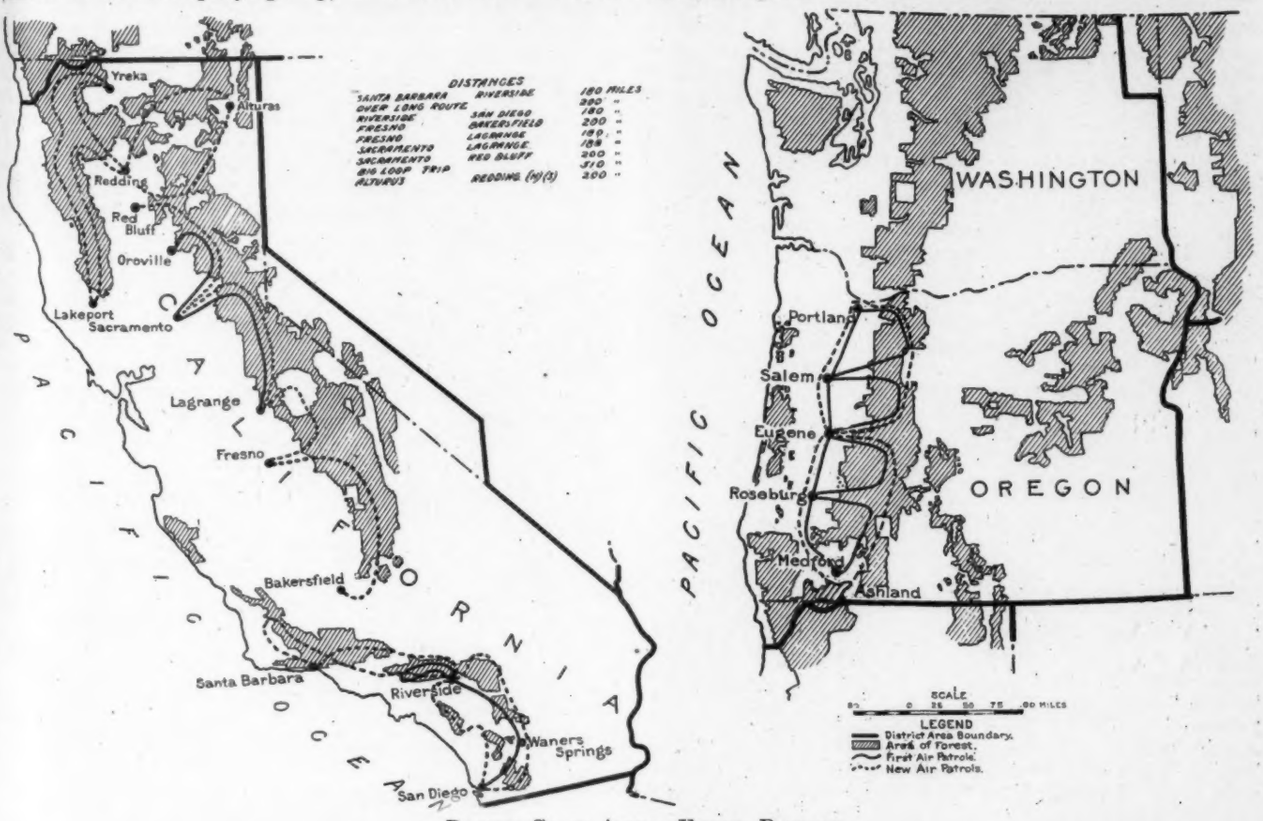
Similar service has been furnished the Post Office Department as an aid to mail-route aviators ever since the aerial mail system was inaugurated. It is likely that arrngements will be made for supplying similar information for the coastal zones of the Navy. Increased demands for aerial observations and forecasts are inevitable in other directions as aerial navigation develops and as an essential factor of success. Meteorological information and forecasts are destined to become of as much importance to navigators of the air as to navigators of the seas.

Aerial Forest Fire Patrol-1920

Extracts from Report of Major H. H. Arnold

The Aerial Forest Fire Patrol for the season of 1920 started when personnel of the Ninth Aero Squadron was moved from Mather Field to Fresno and Red Bluff on May 10, 1920. The patrolling was to conform to the routes outlined on the accompanying map, and was to cover the state duty, beginning operations on July 1, according to schedule.

Radio stations were established at the following places on the dates indicated; the radio personnel for the ground stations, together with the signal corps receiving sets, (No. BC-14-A) being sent out from the Presidio of San Francisco by



PACIFIC COAST AERIAL FOREST PATROLS

of California in accordance with patrol routes as indicated below:

Patrol No. 1—From March Field to Rockwell Field and return.

Patrol No. 2—From March Field to Santa Barbara and return.

Patrol No. 3—From Fresno to Bakersfield and return.

Patrol No. 4—From Fresno to Cooperstown and return.

Patrol No. 5—From Mather Field to Cooperstown and return.

Patrol No. 6—From Mather Field to Red Bluff and return.

Patrol No. 7—From Red Bluff to Alturas and return.

Patrol No. 8—From Red Bluff to Montague and return.

Patrol No. 9—From Red Bluff to Covelo and return.

NOTE: The personnel for Patrols No. 1 and No. 2 was furnished by March Field.

Early in the season it became apparent that the only Air Service troops available for this work would be those from the two squadrons on duty in the Ninth Corps Area, namely, the Ninth and Ninety-first. Accordingly, plans were first made to patrol only the forests in the State of California, as this state has the longest dry season and consequently, the greatest continuous fire hazard.

However, about the middle of May, conditions in Oregon became such that, after a conference between the Governor of the State of Oregon, the District Forester of the Sixth Forestry District, the State Forester of the State of Oregon and the Air Officer of the Ninth Corps Area, plans were completed whereby patrols would start in Oregon about July first.

Flight "A" of the Ninety-first Squadron was, therefore, taken from border patrol and sent to Oregon for forest patrol automobile truck to each station, with the exception of the stations in Oregon, to which places rail transportation was furnished:

Name of Station	*Approximate Date Established*
Mather Field, Calif.	Established between May 10 and May 15
Fresno, Calif.	
Red Bluff, Calif.	
Alturas, Calif.	
March Field, Calif.	
Santa Barbara, Calif.	
Rockwell Field, Calif.	
Hot Springs, Calif.	Established between June 10 and June 15
Senora, Calif.	
Eugene, Ore.	Established approximately June 25
Medford, Ore.	
Portland, Ore.	

Routes

The routes as outlined contemplated a pilot's flying from the base to the sub-base in about two hours, which, together with the return trip, would make about four hours in the air. By having three pilots for each patrol, it was thought that each pilot would in this way have two days off for each day of flying. This was considered the maximum amount of flying which should be required of the pilots, due to the fact that the country over which flights were made was exceedingly rough, emergency landing fields were few and far between and in almost every instance where an emergency, or forced landing was made a complete wreck resulted.

Later in the season, due to the shortage of personnel, it was found necessary to combine patrols Nos. 4 and 5 (from

Fresno to Cooperstown and return, and from Mather Field to Cooperstown and return). When these two patrols were combined, the pilot flew from Fresno to Mather Field in one day returning to Fresno on the following day.

The method of patrolling contemplated the pilot's adhering to the routes as laid out on the map. In case a fire was discovered, the pilot was permitted to leave his patrol route for a distance not to exceed fifteen miles. In order to determine the exact location of the fire and the other details which it was necessary for the Forest officials to have in order successfully to fight the fire.

The airplane patrol usually left the base about 9:00 a. m., arriving at the sub-base about 11:00 a. m. It then remained over until about 1:00 p. m., arriving at its home station again about 3:00 p. m., so that for about four hours of twenty-four the airplane was in the air, covering some part of the national forests. The greatest fire hazard is believed to be during the middle of the day, when the sun is hottest, and when most of the dampness has left the wood. For this reason an attempt was made to have the patrols cover the forests during this portion of the day.

It is not believed, however, that this is the most efficient use of airplanes for forest fire patrol work. It is believed that during the next season a plan of patrol will be developed which will combine the method of patrolling used with a scheme whereby the patrols will be used on special reconnaissance missions for observing and directing the fighting of large fires. Such a use of airplanes was tested in a limited manner during the past season and proved entirely successful.

The maps used were not entirely satisfactory for either the pilots or the observers. There was no standard map available for all parts of the state of California, and Oregon had an entirely different set of maps. In order to remedy this difficulty, a conference was held with the Forest officials to determine the best possible kind of map available for forest fire patrol work. The Forest officials will endeavor to prepare a satisfactory map for the coming season.

Landing fields were developed as rapidly as was possible in all cases. It was endeavored to have emergency landing fields within flying distance of the various patrols, and in order to insure their being kept and marked, steps were taken to interest the various towns along the patrols to prepare such landing fields. The number of landing fields procured in this manner, however, was very limited. It is planned for the coming year to have the Forest Service mark each of the landing fields selected as possible emergency fields. The method of doing this will have to be a Forest official from each district go over the country in the immediate vicinity of the patrols with an Air Service officer, first by airplane and later by automobiles, so that all landing fields will be marked before the patrols actually start.

Airplanes

The airplanes used this year were all DH4-B's, and, although they were criticized in a mild manner, there is no other type of airplane known to the undersigned which would be better adapted to forest fire patrol duty. The majority of the pilots feel that if they had a two-engine plane which could be flown on one engine and which had a cruising radius of about five hours, they would feel safer while on patrol.

Especial attention is invited to the fact, however, that there was only one case of a forced landing during the past season with a DH4-B which resulted fatally—this in spite of the fact that there were 476,085 miles flown, covering a period of 3,994 hours. The cruising radius of the DH4-B was ample, except where very strong head winds were encountered. In some instances this necessitated the pilot's remaining in the air over four hours.

The greatest defect found in the airplane was in the tires. It has been demonstrated by the patrols this year that the rubber in these tires has deteriorated to such an extent that it was practically impossible to tell just when a tire would blow out, thereby causing a wheel to collapse and the airplane to go on its nose and sometimes on its back. There were many such minor accidents during the past season. It is hoped that better tires and better wheels will be secured before the next season starts.

During the first part of the season it was found necessary at various times to discontinue one or more patrols, due to the shortage of supplies for the upkeep and repair of the airplanes. This may have been due to lack of foresight on the part of the supply officers of the various bases. However, steps will be taken for the coming year to see that similar trouble is not encountered.

Radio Equipment

Radio equipment is, without doubt the most important part of the airplane patrol, for without the radio the airplane is practically useless. No matter how many fires the airplane discovers, it would be of no assistance to the Forest Service if reports of such fires were not received on the ground nearly as soon as the fires were discovered. This makes the use of radio equipment imperative, and it was found by actual experience that the radio equipment this year was the weakest link in the entire chain of aerial forest fire patrol equipment. The type of radio equipment used on the airplane was the SCR-73.

Constant communication is essential between the bases and the sub-bases. During the past season this was maintained by airplane, telegraph and long distance telephone. The expense to the Government will be materially decreased if a net work of radio stations such as is herein outlined, is established.

Experience has further demonstrated that the antennae used this year were all too low and were not sufficiently wired. Next year, antennae will be of the 80-foot, 14 wire type. If special problems arise necessitating different type, an inverted "L" antennae will be used in addition.

The life of the generators on the airplane was found to be about ten flying hours. After this the generators ceased to function, and, in many cases could not be repaired. This coupled with the lack of radio supplies and equipment in this Corps Area, put the radio on the airplanes out of commission very frequently. Steps are being taken to secure sufficient supplies for the coming season, so that this handicap will be eliminated.

Personnel

The efficiency of the pilots and observers during the work of the past season increased in proportion to the time they were on patrol duty, which was, of course, but natural. In aerial forest fire patrol work the pilot leaves the ground in summer when the weather is hot, and rises to an altitude of ten to fifteen thousand feet, at which height most of the patrols are flown, and at which altitude it is found that the temperature is more or less cool even when the weather is hottest in the valley. The work is in may ways similar to activities in war time.

The fire must be spotted from a distance. It is then approached and circled at a lower altitude than that at which the patrol is flown, during which time the observer secures all the information possible as to the progress being made by the fire; its general direction of advance; its size, and the character of the timber being burned. This information is sent from the airplane by radio to the nearest Forestry liaison officer, the location of the fire being determined by landmarks which must be known beforehand by both the pilot and observer.

All ships must be ready to leave on patrol when the time comes, and the pilot and observer are each given their turn, and take their turns regularly, regardless of any minor conditions which may have a tendency to interfere. Aerial forest fire patrol means a continual grind, with no relief until the end of the season.

In addition to the actual flying tests the opportunities for training mechanicians and engineer officers are without equal in peace-time flying. The continual flying is a constant strain on the airplanes, during which they must meet the most severe conditions—conditions which prove an unerring guide to the ultimate weakness or strength of the airplane and engine used.

Viewing the activities of the past year as a criterion, it is essential that three pilots and three observers be available for any one route followed. This will give each pilot and observer two days off out of three, or assuming that the patrol routes are of the same distance as those flown this year, each pilot and observer will fly about forty to fifty hours a month.

It will be necessary in addition especially to train the pilots and observers for their work for a short period before the patrols are actually started. The length of this period of training will naturally depend upon the adaptability of the

personnel. In this connection, an agreement has been reached with the District Forester whereby, if possible, a school for the special training of foresters, pilots and observers will be opened at Mather Field, commencing about January 15, 1921. Based upon what was accomplished at a similar school held at March Field during the past season, such a school will do more to bring about cooperation between the foresters, pilots and aerial observers, than any other one move which can be made. It has been decided, tentatively, that the course of instruction at this school should comprise about two months. A course of instruction will be drawn up at Mather Field and submitted for approval, however, before any final arrangements are made.

Observers should be selected, if possible, from civilian reserve officers who have been trained as observers or pilots. These officers can be placed in the employ of the Forest Service, thereby giving them an official standing with that service. Such men are much more efficient than any enlisted observers who may now be secured. If it is impossible to obtain a sufficient number of this type of men, those needed in addition should be secured from cadet personnel. However, enlisted and civilian observers should never be stationed at the same base or sub-base together.

During the past season, due to the shortage of officer personnel and to other exigencies of the service, certain of the pilots on patrol were obliged to fly as much as sixty hours a month. Flying over thickly wooded country for such extended periods of time, with landing fields few and far between, gradually began to tell upon the pilots and observers, and the result was only what could be expected under these conditions —breakdown at just the most inopportune period of the patrol season.

The most efficient pilots became nervous, and did not do work commensurate with their ability. Those of lesser ability had their morale more or less weakened, and this affected their flying to such an extent that the crashes increased at an alarming rate. For instance, there were four crashes in one day from one base. It is true that some of the crashes were of a minor nature, but it is more probable that none of them would have occurred had the pilot's efficiency been up to the standard. This condition was remedied by changing commanding officers; affording new amusements and recreation when the pilots were not on duty; making certain that the pilots and observers went away on hunting and fishing leaves; and combining patrols so that less work was required of the same group of men. The results obtained after these changes were effected speak for themselves.

In connection with maintaining the morale of the pilots and observers during the strenuous work of aerial forest fire patrol, there originated with the Forest Service, during the early part of the season, an idea for establishing a recreation camp to which the pilots and observers could go in order absolutely to forget flying and the worries incident thereto. After conference with Air Service officers, the culmination of this idea has been the tentative setting aside of several hundred acres of land in the Kennedy Lake district in the Stanislaus National Forest, where excellent hunting and fishing are available. This area of land will be used for a recreation camp, as mentioned above.

At the present time, this country is more or less snowed in. As soon as it opens up in the Spring, an Air Service officer will be sent there with a Forest official to stake out several hundred acres of land. It is proposed during the coming season, to send all pilots and observers up to this district, having them spend at least two weeks out of every two months in the woods. Cabins will be built by the Air Service personnel from time to time, and it is hoped that the camp will be built and in full use by the middle of the coming summer.

During the past season the Forest Service has in all cases met the Air Service more than half way. When it came to a question of sparing pilots and machines at the expense of patrols, forest officials themselves were always the ones to suggest the change. Forest rangers, district supervisors and other forest officials went over the patrols as observers, using the airplanes time after time on special missions for observing and directing the fighting of a particularly large fire.

While the forest patrol, as carried on during the season of 1919, was an experiment which proved that the airplane could be used successfully for spotting forest fires, the patrols during the past season not only successfully located forest fires, but also actually directed the fighting of the large fires, and, in some instances, carried personnel from one part of the state where their services were not needed, to another part of the state where their services were very urgently required for fire fighting.

Maurice G. Cleary

Captain Maurice G. Cleary was born in Everett, Wash., and graduated from the University of Wisconsin. He entered the Air Service in April, 1917, and graduated from the Ground School, University of California; the Primary Flying School, San Diego, and the Advanced Flying School, Kelly Field. He became an Army Corps pilot by taking the course at the School of Aerial Observation at Fort Sill. He commanded the 352nd and 48th Aero Squadron and for a time was in command at Mitchell Field. As adjutant, Supervisor's Branch, Director Air Service Office, he was on duty in Washington. Later he came to Mitchell Field as Adjutant of all Aviation Activities on Long Island. He was one of the pilots in the New York-Toronto race. His work as the active director of the Aero Club of America is beginning to show results and it is believed that under his guidance the club will make great progress.

MAURICE G. CLEARY
GOVERNING DIRECTOR, AERO CLUB OF AMERICA

The Spanish Infante in a F-5-L

A report has been received at the U. S. Naval Air Station, Coco Solo, Canal Zone, that Prince Don Fernando, the Infante of Spain, and his party stopped at the Air Station enroute to Chile. The Prince was given a flight in an F-5-L type of seaplane, which was his first air trip.

A dive in a submarine was also arranged for the Prince, but he stated that his time was limited and that he would prefer to fly rather than dive.

The Possibilities of the Large Airplane *

By F. H. Norton

Before taking up the structural and aerodynamic problems of the large airplane, it will perhaps be advisable to consider in what respects the large machine is superior to the small one, as the former has the obvious disadvantages of high initial cost and of requiring large landing fields.

Airplanes may be divided into two classes, war, and commercial. In the first class a large machine would be desirable for some kinds of work, for the same reasons that large battleships are desirable, namely that they may carry heavy armor and armament and make long cruises. The large war plane is also of value for long distance night bombing. In commercial work the first object is of course, to make a profit by cutting down expenses without endangering the lives of the passsengers. From this viewpoint the large airplane would offer distinct advantages for heavy traffic or for long distances. As it takes at least one pilot to fly a machine whatever its size, it is obvious that the number of high salaried men will be reduced by the use of larger machines.

Another point that is of considerable importance in commercial work, is comfort to the passengers, and the large airplane is superior in this respect as it may have a proportionately larger cabin, it rides more easily in bumpy air, and its motions are slower. Taking everything into consideration, it seems very probable that the large machine will be extensively used if it can carry more useful load than the small machine for a given total weight, or can fly faster with the same proportional power; but if the efficiency does not increase with the size the use of very large airplanes will at least be very limited.

The problems presented by the increasing size of heavier-than-air machines are very serious ones, and their solution is quite certain to depend on a more or less radical departure from the present methods of airplane construction. Up to now the inherent tendency of the structural weight to increase faster than the total weight of the machine, has been combatted by the more efficient use of material, and by a reduction in the factor of safety in the larger machines; but it is evident that this cannot go on indefinitely, and a size will be reached when the load carrying efficiency will begin to decrease. Just what that size will be with the present type of construction cannot be definitely determined, for up to the largest sizes that have been actually constructed there is little, if any, falling off in the percentage of useful load. It is clear, however, that the factor of safety cannot be much reduced in the larger sizes, and the gain in efficiency due to the subdivision of material will be less marked.

As the size of the airplane increases it becomes more and more desirable to use metal exclusively in its construction, both for structural efficiency and permanency. There is no reason why a metal airplane should not give service that is comparable with a ship, for it has very little wear or stress when in the air, and the time that it is moving on the ground is but a brief period of its existence. The metal machine could also be left out of doors, thus eliminating a very costly hangar.

The efficiency of an airplane can be divided into two classes: structural and aerodynamic. In order to study the former, the loads usually acting on the airplane will be discussed, together with the possibility of their modification. The greatest air load acting on the machine is the resultant air force on the wings which in steady flight is balanced by the weight of the machine and the thrust of the propellers. As this air load is nearly uniformly distributed along the span of the wings, it is evident that with the weight and thrust concentrated in the center of the span, as is the case in small machines, the stresses set up in the wing truss will be large. (Fig. 1).

If, however, the weight and thrust are distributed along the span (Fig. 2) the stresses in the wing truss will be diminished. Unfortunately the air load is not constant in position for various flight speeds, but moves back and forth along the chord. This movement produces a pitching moment about the center of gravity, that must be balanced by a load on the tail. If the tail is attached to the center of the span, it will exert a twisting stress in the wing truss, although this will be much less than the stress due to the weight of the machine. This stress can be reduced to any degree by distributing the tail along the span as in Fig. 3.

The preceeding loads are those occuring in steady flight, but there will be, in accelerated flight, additional loads added to these. When pulling out or going into a dive there will be a considerable tail load which is balanced by the longitudinal moment of inertia of the machine, and by damping (Fig. 4). The stresses due to the aileron forces in rolling in or out of a bank are more complex and will require a more detailed analysis. (Fig. 5).

When the ailerons are turned in flight a force is exerted near the wing tips and this is balanced by the damping effect of the wing, and by the lateral moment of inertia of the airplane. The forces from both of these sources, assuming a uniform distribution of weight along the span, will vary as the square of the distance from the center of the span, so that with this distribution of load there is very little stress set up in the wing truss due to aileron loads. To illustrate this more clearly, load curves are drawn to scale in Fig. 6, showing the very close balance of forces. Let us assume that while the airplane is in steady flight the ailerons are turned suddenly to a given small angle which will set up a constant rolling moment. At the first instant there will be no angular velocity and therefore no damping so that the only resulting force will be inertia, but as the time increases the damping will increase and as the angular velocity becomes constant the intertia forces will disappear and the damping force will be alone.

It is theoretically possible to produce a machine that will have in steady flight and at one angle of incidence no stresses in its main members, and in all other conditions of flight will have only small stresses in any members. These conditions are however, inconsistent with small stresses under landing conditions as in Fig. 7. If the landing wheels are distributed along the span, the landing loads can be made as small as desired, but it will be argued that when landing on uneven ground that only a few of the wheels will take the load, thus causing high stresses, but a possible solution of this difficulty will be discussed later.

The methods to be used in gaining aerodynamic efficiency are very simple, but generally are incompatable with structural efficiency. The various properties of an airplane that are conducive to high efficiency may be summarized as follows:

1. High aspect ratio.
2. Monoplane construction.
3. An efficient wing section.
4. Low structural resistance.

Now that we have a machine that is theoretically satisfactory, let us see how closely we may approach it practically. In the first place the load must be distributed along the span. This is done to some extent at present by placing the power plants and gas tanks out on the wings, but as we are mainly interested in large planes, the problem can be solved more satisfactorily by placing all loads inside of the wing.

It will, perhaps, be clearer if a concrete example is taken, and for this purpose, the following monoplane has been worked out. (Fig. 8).

Span	300 ft.
Chord	50 ft.
Length	140 ft.
Supporting surface	15,000 sq. ft.
Weight of machine empty	100,000 lb.
Weight of useful load	100,000 lb.
Loading (full load and power)	13.2 lb. per sq. ft.
Loading (full load and power)	25 lb. per hp.

A cross section of the wing is shown in Fig. 9 in order to bring out the large amount of room in a wing of this size, allowing the power plant, tanks and passengers or freight, to be placed anywhere along the span. It has been thought until recently that a wing of this thickness (1/5 of the chord) would be extremely inefficient, but wind tunnel tests show that

* The conclusions in this article are the author's but AVIATION publishes it as a stimulating conjecture.

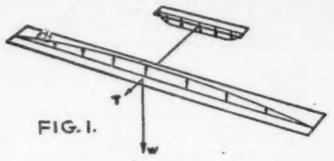
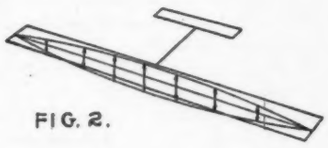


FIG. 1.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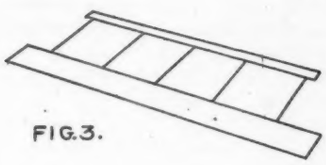
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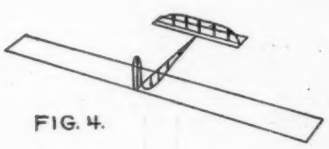


FIG. 4.

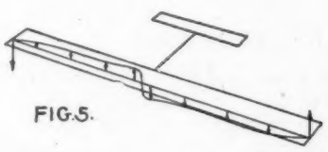


FIG. 5.

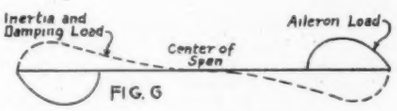


FIG. 6

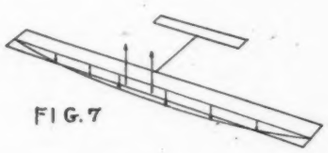
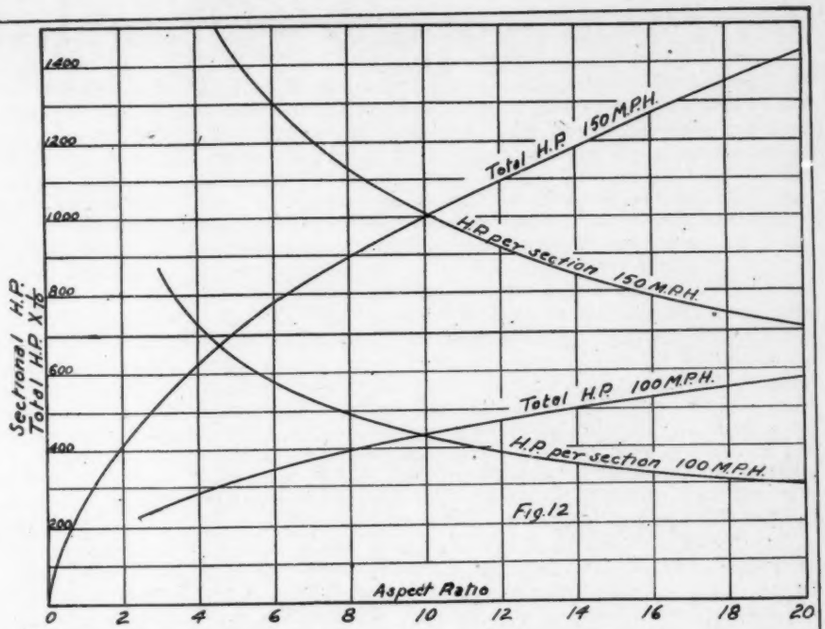
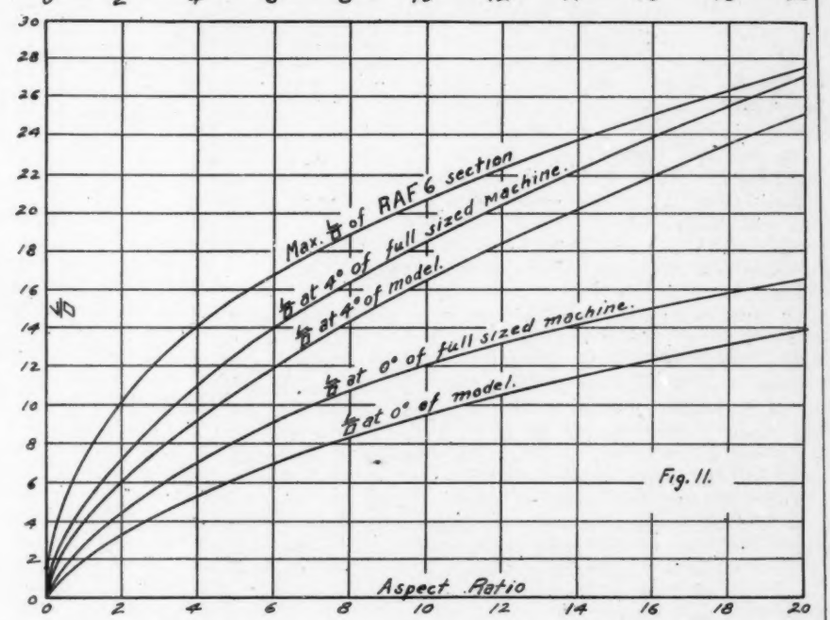


FIG. 7




Max. L/D of RAF 6 section
L/D at 4° of full sized machine.
L/D at 4° of model.
L/D at 0° of full sized machine.
L/D at 0° of model.
Fig. 11.
Aspect Ratio
0 2 4 6 8 10 12 14 16 18 20

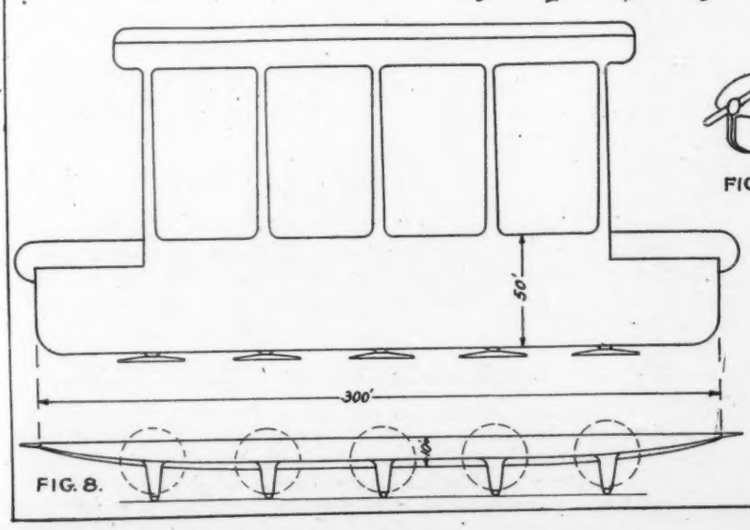


FIG. 8.

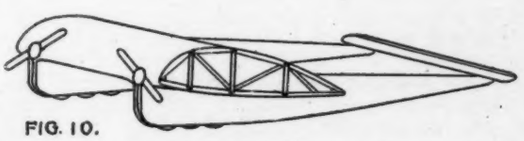


FIG. 10.

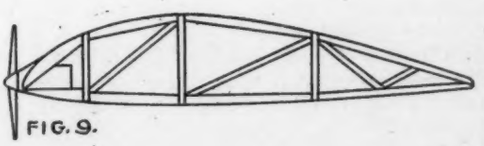


FIG. 9.

FIGS. 1 TO 12

the efficiency is very close to that of a thin wing, and when the thick wing is compared to a thin winged biplane with its interplane bracing, the former is distinctly superior.*

In this machine it is possible to incorporate nearly all of the theoretically desirable qualities; the load can be distributed in any desired manner along the span, and the tail and chassis loads are quite well spread out. In order to have equal loads on all wheels in landing it is proposed to connect all the hydraulic shock absorbers to an equalizing pipe, so that the loads will always be evenly distributed between the wheels.

This type of structure not only reduces the structural weight, but it also increases the aerodynamic efficiency, as evidenced by a wind tunnel test of a model of the foregoing airplane which gave a maximum L/D ratio for the total machine of 12.5 whereas in the usual machine it is between 6 and 8. The performance calculated from this test would indicate a maximum speed of 136 m.p.h. and a climb of 330 ft. per min. fully loaded which is very high for a machine with this power loading. That a high efficiency is attained in actual machines by using thick internally braced wings is evidenced by the Fokker and Junker airplanes, although these machines are too small to take full advantage of it by enclosing their load in the wing. The new Zeppelin all metal machine has gone a step further and has large enough wings for a man to crawl through.

There is another method of obtaining even greater aerodynamic and structural efficiency, but it contains many new and untried ideas that would require a great deal of study and development for their practical application. This method consists in constructing a non-rigid or articulated airplane, made up of a number of similar segments each containing its own power plant, chassis and controls, all connected end to end by flexible joints. This construction, in short, permits the structural advantages of a low aspect ratio and the aerodynamic advantages of a high aspect ratio. Let us assume that these units will have a chord of 50 ft., a span of 50 ft. and a wing depth of 10 ft., and will weigh loaded 30,000 lb. (Fig. 10) These sections will be connected end to end like a train of cars, and each section will furnish its own thrust and will support its own weight. It is evident that sections of this type may be made very light structurally, as all the load is closely over the air that supports it.

In order to show the gain in efficiency by using a high aspect ratio, the L/D for a wing of the R.A.F. 6 type is plotted against aspect ratio. (Fig. 11) This wing was chosen simply because it is the only one that any tests have been made on at high aspect ratios. Both wind tunnel experiments, and theoretical analysis as carried out by Dr. Prandtl at Goettingen,† show that the efficiency of a wing increases with the aspect ratio without limit, contrary to the previous belief that the efficiency reached a maximum at some definite aspect ratio.

In Fig. 11 is drawn a curve to show the efficiency at four degree incidence of the model for various aspect ratios based on a test at aspect ratio six, and also a curve of efficiency for the full sized machine derived from the model curve by the usual scale corrections.

In the same way curves are plotted for the efficiency at zero incidence. Of course this data is not exactly correct as it would be necessary to conduct more wind tunnel tests to make it so, but it is fairly close to the truth, and will serve as well for an example.

Assuming somewhat arbitrarily that the machine will fly at four degree incidence at 100 m.p.h., and at zero incidence at 150 m.p.h., curves for horsepower required are plotted for various numbers of sections in Fig. 12. In this figure are also plotted the horsepower per section, for various numbers of sections. It is clear that the power per section is reduced to less than one-third as the number of sections is increased from three to twenty. The 20-section machine would be able to fly at 100 m.p.h. with a loading of 100 lb. per hp., so that the whole 300-ton airplane would require 6,000 hp. at this speed.

To show more clearly what this means, suppose a 3,000 mile flight is made across the Atlantic in 30 hours using 6,000 hp. Assuming that the fuel consumption is one half pound per hp./hour, the total weight of fuel needed for the trip will be 45 tons or 15 per cent of the total weight of the machine, leaving at least 150 tons for passengers and freight. At 150 m.p.h the power will be 14,000 hp., and for a 3,000 mile flight would require 70 tons of fuel or 23 per cent of the total weight.

The longitudinal control of a machine of this type would be accomplished as usual, except that each section would be automatically maintained at the proper angle of incidence to support its own weight at the velocity of the machine. The lateral control will not be as simple and turns can be made only with gentle banks. As the use of ailerons is impossible, the sections on each side of the center of the machine will change their angle of attack in opposite directions, by means of their individual tail planes, so that one side of the machine climbs and the other dives, thus producing a bank. In addition to this the engines would probably have to be used to complete the turn without side slipping.

A machine of this type would have a great many practical difficulties to be overcome, especially in the manner of control, and it is suggested only to show what the possibilities are of large, highly efficient airplanes. The articulated machine would, however, possess several distinct commercial advantages, namely that the number of sections could be varied to suit the load, and any one section could be repaired without putting the whole machine out of commission.

From the preceding considerations, it seems probable that the large machine of the future will have a high aspect ratio and a monoplane construction to obtain aerofoil efficiency; it will have all possible parts enclosed within the wing, and will so distribute the loads that the main members will have the minimum of stresses. In other words, only those surfaces that serve to support or control the airplane will be presented to the air flow, and each portion of weight will be placed as closely as possible to the portion of the surface that supports it.

*The Aerodynamic Properties of Thick Aerofoils Suitable for Internal Bracing, N.A.C.A. Report No. 75.

†N.A.C.A. Technical Notes Nos. 9 and 10.

A New Lathe Tool

A tool designed to cut a standard radius on a lathe or planer has recently been placed on the market by the R. G. Smith Tool & Mfg. Co. The usual practice in most machine shops, when an "accurate" radius is to be cut, is for the machinist to "fiddle around" and make a special tool for each individual job. A ¼ in. convex tool is made, for example, is used on a job, and if it survives the job it is lost or is thrown away because such tools are not designed for being reground. To regrind a tool of the usual make requires nearly as much time as to make a new one. Besides these tools are not made accurately. Or, the machinist decides to turn the round or groove directly on the work itself by the cut and try method, using tools of various shapes for the operation varying all the way from a diamond point to a rat-tail file. Usually the result is far from accurate.

Cutters for various radii, convex and concave, are now made for milling machines. All production men know how accurate, dependable, and convenient such cutters are. The tool described herein is equally accurate and convenient for the lathe, planer or shaper.

The tool consists of a metal disc whose circumference is cut at the desired radius. A notch is cut in the edge of the disc and the section of the circumference so exposed acts as the cutting edge. This edge is easily and accurately ground and the tool lasts until the whole circle is used up.

With this tool when a machinist wants to turn a ¼ in. radius, whether concave or convex, he simply inserts a standard ¼ in. cutter in the Smith holder and immediately proceeds to do the work accurately. They are all interchangeable. The cutter shank slips into the holder either from the right side or from the left side, depending upon where the machinist wants it.

Engine Performance at Carlstrom Field

The Engineering Department at Carlstrom Field reports that it is getting remarkable performance from its engines; such performance as they believe sets a new record in this line.

Instead of being necessary to send an engine to the overhaul after thirty-five or fifty hours in the air, it is now possible to get two hundred and even two hundred and fifty hours from the Wright engines being used there.

Monthly Report of Air Mail Service

October, 1920

Division	Gas.	Grease and Oil	Office Force and Watchmen	Motor cycles, Trucks	Rent, Light, Fuel, Power, Telephone, and Water.	Misc.	Pilots	Mechanics and Helpers	Repairs and Accessories	Interest on Investment	Departmental Overhead Charge	Total
New York—Washington	$2,504.46	$312.09	$1,038.55	$1,118.90	$560.99	$546.53	$1,270.13	$3,322.88	$3,157.64	$756.25	$396.78	$14,985.20
St. Louis—Twin Cities	1,508.29	358.93	956.47	480.91	146.93	3,209.23	942.25	2,667.86	876.39	924.10	505.78	12,577.14
New York—Cleveland	3,689.77	460.41	1,535.87	1,475.82	418.24	1,715.21	2,391.31	3,869.59	7,048.81	1,718.75	614.82	24,938.60
Cleveland—Chicago	3,364.43	581.42	1,187.97	863.62	178.53	2,355.54	1,404.06	2,107.07	2,365.25	1,547.08	614.82	16,569.79
Chicago—Omaha	2,216.98	477.67	730.75	570.06	85.56	1,137.83	2,190.76	2,569.49	2,700.33	425.83	614.82	13,720.08
Omaha—Salt Lake	5,603.01	1,250.21	1,271.48	611.99	287.31	1,694.97	1,838.94	3,606.40	3,264.57	514.17	1,541.27	21,484.32
Salt Lake—San Francisco	2,073.00	400.12	1,780.25	706.65	136.35	5,605.50	952.40	3,061.18	3,158.33	310.00	1,159.77	19,343.55
Totals and Averages:	$20,959.94	$3,840.85	$8,501.34	$5,827.95	$1,813.91	$16,264.81	$10,989.85	$21,204.47	$22,571.32	$6,196.18	$5,448.06	$123,618.68

Service and Unit Cost

Division	Gal. of gas.	Total time run. hr.	min.	Total miles run.	Miles run per gal. of gas.	Cost per hour	Cost per mile.
New York—Washington	6,854	236	06	19,242	2.8	$63.47	$.78
St. Louis—Twin Cities	4,133	182	23	13,713	3.3	68.96	.92
New York—Cleveland	10,374	329	01	26,048	2.5	75.79	.96
Cleveland—Chicago	9,695	200	47	17,020	1.8	82.52	.97
Chicago—Omaha	8,058	237	40	20,566	2.6	57.73	.67
Omaha—Salt Lake	15,058	480	56	42,049	2.8	44.67	.51
Salt Lake—San Francisco	5,838	186	03	15,848	2.7	103.97	1.22
Totals and Averages:	60,010	1852	56	154,486	2.6	$66.71	$.80

Cost Per Mile

Division	*Overhead*	*Flying*	*Maintenance*
New York-Washington	$.20	$.21	$.37
St. Louis-Twin Cities	.22	.20	.50
New York-Cleveland	.22	.25	.49
Cleveland-Chicago-	.26	.31	.40
Chicago-Omaha	.12	.24	.31
Omaha-Salt Lake	.10	21.	.29
Salt Lake-San Francisco	.26	.22	.74
Entire Service	$.18	$.23	$.39

Planes Operated

New York- Washington Division

Standard, equipped with Hispano-Suiza engine.
Curtiss R-4's, equipped with Liberty 12 engines.
Curtiss JN-4D's, equipped with Curtiss OX-5 engines.
De Havilands, equipped with Liberty 12 engines.

St. Louis-Twin Cities Division

Standard, equipped with Hispano-Suiza engine.
Curtiss JN-4H's, equipped with Hispano-Suiza engines.
Twin De Havilands, equipped with two Liberty 6 engines.

New York- Cleveland Division

Curtiss R-4's, equipped with Liberty 12 engines.
Curtiss JN-4D, equipped with Curtiss OX-5 engine.
De Havilands, equipped with Liberty 12 engines.
Twin De Havilands, equipped with two Liberty 6 engines.

Cleveland-Chicago Division

Standard, equipped with Hispano-Suiza engine.
Curtiss JN-4, equipped with Curtiss OX-5 engine.
De Havilands, equipped with Liberty 12 engines.
Twin De Havilands, equipped with two Liberty 6 engines.
Martins, equipped with two Liberty 12 engines.

Chicago-Omaha Division

Curtiss JN-4D, equipped with Curtiss OX-5 engine.
De Havilands, equipped with Liberty 12 engines.
Twin De Havilands, equipped with two Liberty 6 engines.

Omaha-Salt Lake City Division

De Havilands, equipped with Liberty 12 engines.

Salt Lake-San Francisco Division

De Havilands, equipped with Liberty 12 engines.

Europe Recognizes Success of U. S. Air Mail

Transportation of the mails by aircraft won recognition and approval at the International Postal Congress at Madrid, according to Otto Praeger, Second Assistant Postmaster General, who represented the United States and who returned recently on the Cunarder *Aquatania.*

"There is intense interest in the Air Mail throughout Europe," said Mr. Praeger. "Practically every country either has opened an Air Mail experimental line or plans to do so in the near future. The report of the U. S. Air Mail Service which I submitted to the congress was the subject of much discussion. Many countries have asked for more detailed information, particularly Denmark, Norway and Sweden, which already have some posts carried by air but are eager to extend the system.

"The International Postal Congress recognized the transportation of mail by aircraft and prepared the way for signatory powers to enter into agreements for special compensation where it was desired to transmit postal matter either wholly or partly by air.

"Europe is criss-crossed with Air Mail lines radiating from London, Paris, Copenhagen and Berlin and extending through every country on the Continent. The English and French services between London and Paris are eminently successful, while their branch routes through other countries are developing rapidly. Holland, Belgium, Switzerland, Germany and Spain are fostering mail routes either by government operation or by private companies. Italy had a government air mail service between Turin and Rome, but has had difficulty retaining planes and aviators; a pilot setting out with his plane well supplied with gasoline, would fly over to Fiume and join D'Annunzio's forces.

"Czecho-Slovakia is organizing an air mail service between Prague, Warsaw and Paris, fostered by French capital. Other nations are following the example of France which has established great junction points, one at Nice for all traffic between Rome, Paris and Bucharest, while at Strasbourg it has established a junction for planes flying between Germany, Poland, France and Russia. One reason for success in Europe is the availability of landing fields. A pilot finds an airport wherever he flies. The French believe that within ten years the public will use airplanes as much and for as many purposes as it now uses railroads. More than one thousand persons have flown from Paris to London in French machines alone."

Electric Heaters for Mailplanes

In the Air Mail hangars at Cleveland there are installed electric heaters which are hooked on the lower half of the crankcase and so keep the engines warm. This is a great assistance in keeping the schedule as the machines not only start easier but are less likely to develop trouble after they leave.

Library
Air Corps Tactical School
Langley Field, Va.

Women in the Aircraft Industry

The war opened many promising fields of useful activity to women but none more favorable, in its future aspects, than the aircraft industry. An enormous production program, adopted at a time when men were being drawn into the Army, impelled the employment of women, at first through necessity rather than through choice. The results were significant.

The airplane, employing as it does literally scores of trades, stands at the pinnacle of industry. Wood, metal and fabric working, paints, dopes, varnishes, each process requiring both skill and patience, offered women an extraordinary opportunity. At the height of production, Nov. 11, 1918, when it is estimated some 250,000 persons were employed directly and indirectly in the industry, it is believed that more than 25,000 were women.

The cessation of hostilities required severe contraction in the war-time aircraft industry. It is difficult to approximate the number of persons employed, as of December 1, 1920, but it is safe to state that the proportion of women to men remains about the same as at the time the Armistice was signed.

While the contraction of the aircraft industry means that the majority of women employed during the war have been dismissed, it does not mean that the skill thus developed has been lost. To the contrary there is evidence to indicate that many women have utilized their extraordinary training to go into other trades such as automobile, machine, furniture, etc. The following reports from companies are typical of the entire industry rather than restricted to the firms referred to: One large automobile company which turned out 6,500 Liberty engines during the war, in addition to doing most of the preliminary experimental work in its Detroit plant, and training the inspectors and supervisors who had charge of the manufacture of Liberties in other factories, made extensive use of women workers in this production. They were found to be extremely satisfactory and in the readjustment period, when the factory turned out more to the production of automobiles, a majority of them were kept on the payroll. While the number of women used in the production of Liberties varied considerably at different times, 2,000 was a fair average.

The women were employed chiefly on light machine jobs. Among those that they handled were drill-presses, milling machines, gear-cutters, lathes, grinders, punch presses, and automatic screw machines. They were also used on light assembling, on acetylene welding, and core-making. A considerable number became inspectors, especially of the small machine parts, and others were employed as clerks checking production and time.

On light machine work, where no great physical effort was required their production compared very favorably with that of the men. On light assembling, their output equalled that of the men. On inspection, where the work was small, tedious, and required the use of micrometers and gauges, their output was greater than that of the men. They showed a manual deftness and speed which very few men could equal, and also showed a steadiness and faithfulness in keeping at their work which was superior to that of the average man.

The Curtiss Aeroplane & Motor Corp. employed more than 9,000 women during the height of production at their Buffalo and Garden City plants in 1918. The work which the women did consisted of coppering, wing-covering, aluminum-welding, light painting, wire-wrapping and splicing, soldering, filing and packing. It was necessary, owing to the fact that most of the girls were inexperienced, to operate a training school. The graduates of this school became trained and efficient workers. Even in the most difficult and technical work, the women had no difficulty in mastering it. In a great many instances, they did the work even better than the men could have done it. Enthusiasm ran high, and most of them preferred this kind of work to office routine, etc.

The Glenn L. Martin Co. of Cleveland, Ohio, found that women were easily adapted in aircraft industry, and the operations and processes to which they were best suited were the shearing and finishing of the numerous small wood blocks and parts that entered into the wing construction. In this type of work women were particularly at an advantage, due to the fact that the work is tedious and monotonous, and it was noticeable that the girls were more willing to perform such operations than men would be.

In the inspection department, also, women were an advantage in inspecting the above mentioned small parts, the general tendency being that girls were more particular and exacting in passing judgment on questionable parts while undergoing inspection. In the finishing department, where the linen and cotton cloths must be cut into patterns and stitched by power machines, and this covering being applied to the wings and sewed in place, it was found that in this particular operation women were especially qualified and efficient. The taping of the wings and stitching of tape to the body was another operation to which they were especially adapted.

The Manufacturers Aircraft Association, in investigating the work of women in aircraft production during the war, found that in light operations where the work was more or less tedious, the women were particularly qualified, as it seems to be characteristic that they are more willing to apply themselves to this nature of work than a man or boy, due to the fact that the man or boy will realize while working, that his efforts on a particular operation must be such that it will train him in the trade for positions which will pay more as his skill increases. The girl, however, has an entirely different future to look forward to, and is interested in only the immediate returns.

In comparing production results, it has been found that on work of the above mentioned type, the women will be as efficient as men both in quantity and in quality. In most of the aircraft factories the women were paid less than the men. In fact, an hourly rate applied to women will be about 60 per cent of the male help if applied to the same operation. This however, is contingent upon conditions prevailing whether it would be a piece-work rate or hourly basis. In the former event no doubt the earnings of the women would compare evenly with that of the men.

In the Burgess Company's factory at Marblehead, Mass., women were used in propeller-making and cable wire work. Instead of passing them through a school of instruction, this company trained its women workers by actual work alongside of the men. This showed that women are easily adapted to this sphere by going to school or by immediate contact with the work in hand.

The Thomas-Morse Co. recruited its workers from girls in Ithaca, some of whom had never worked before in any business. Neither this firm nor the Aeromarine Plane and Motor Co. found it necessary to open special schools for the women. They were instructed by the foreman, but in the main they taught themselves.

The Glenn L. Martin Co. has found that it was to their advantage to retain female help in the finishing department as this is a light and natural operation for women. The production and factory manager of this company states that there is no doubt that women will remain indefinitely in this department of the aircraft industry. It was originally intended to keep women operating the shearing machines and inspecting small wood parts, but this company has found that since the Armistice they have been in a position to secure boys who are able to do the work as efficiently as women, thereby releasing the women from this work. The Curtiss Aeroplane & Motor Corp. has retained a few of their skilled women workers.

There is no doubt that as the aeronautic industry grows women will again take their place in the aircraft factories. It is the opinion of the production managers that women have demonstrated their worth and will prove valuable help in years to come.

Naval Reserve Men on Southern Cruise

* The commandant of the Third Naval District, has recalled to active duty for training one hundred and sixty enlisted reservists of the district, for the cruise of the Atlantic fleet to southern waters.

Dopes for Gasoline

C. F. Kettering at the Annual Meeting of the American Petroleum Institute held in Washington in November told the producers of gasoline some plain truths regarding the gasoline they were furnishing the public and incidentally referred to some experiments that had been made in introducing different kinds of "dope" into cylinders of high compression engines. Sections of his address are of interest to the aeronautic engine man and are given as a suggestion of what may be an important development in the use of gasoline for aviation purposes. He said in part:

"We have it on good authority that if we took 10 per cent of the heavier ends out of our fuel today we could run even more economically than we do now, but we have got to reverse this very interesting fact, that as we lower the compression of an engine we lower the efficiency of it.

In order to get to you this problem as we see it, here is what happens: If we try to burn the present-day fuel which is sold at the average filling station in a high compression engine, we will say, like an airplane engine, we cannot do it. We cannot fly. It is almost impossible to get off the ground if you have to fill your machine with ordinary automobile gas. The reason is that we get that awful knocking in the motor. Most people call it a carbon knock. We find that with a high-compression engine, like an airplane engine, where the compression is 125 pounds to the square inch at about three-quarters or two-thirds of the maximum power, if you open the throttle to get two-thirds or three-quarters of the maximum power those explosions get so intense that they just cave the piston heads in. That, gentlemen, is the real fuel problem. We cannot raise the compression of our engines because of the fact that if we do, when you throw the throttle wide open when the motor gets a little bit dirty, the motor pounds so hard that it will fracture the porcelains in the spark plugs, break down the bearings, and do all sorts of things. It will wreck the engine.

When we lower it to the point where we can throw the throttle wide open and still not subject the engine to undue strains, we work but very little of the time at that demand. In other words, the percent of total time that an automobile engine is asked for full power is very small; but you have got to drive that engine along twenty or thirty miles an hour when the throttle is very nearly closed, when the compression is dropped down to maybe a third or a quarter of what its maximum is, and we burn 90 percent of all our fuel down there at that very inefficient point.

At McCook Field, they took a standard engine which with good average gasoline would give about 250 horsepower and put in that same engine the automobile gas. They got 350 or 400 horsepower and it caved in the piston heads. They put new piston heads in that gave them 160 pounds compression and put the same automobile gas with seven percent of dope—a mixture of aniline and xyloline, and some other 'ines—and they pulled out of that engine 500 and over horsepower. The explosion pressures were not quite so high on those cylinders as they were when they were pulling 400 horsepower out of it with the other gas, because it is not how high that explosion pressure goes but it is how long it persists that gives you the power. So if you can take out the peak hammer-blow you can get along very nicely.

Now the thing we need and the thing we have got to jointly work to get is these dopes, and get them on the market.

A very peculiar thing happens when you begin to use these dopes. After a while the carbon goes out of the engine. Those dopes were all alkaline and the binder is an acid, and one neutralizes the other. In other words, anything that is a varnish remover is a carbon remover. That is all there is to it. So you can put any kind of a varnish remover in if it is the right kind. It will take the carbon out anyhow, but it may stick up the engine.

I am going to analyze this thing in a very simple form so you will get the point. There are but very few difficult problems. First is the question of volatization, which I think can be worked out by the ordinary mechanical means, by the application of heat. Then we have the starting problem, which is quite a serious one. I think we will have to resort to having you put on the market a highly volatile stuff like petroleum ether, or something of that sort. This we can use with a little can and a little primer that doesn't cost much and for which you can charge $5 to the consumer. You can prime this engine with a little high volatile stuff. Your engine will shoot. It only takes a few shots to take the chill off the engine. Then your heat applications come on and the thing does pretty well.

That will handle the question today so far as the used part is concerned. But the big thing we have to get to is the increase in economy. In other words, we have to do more work for the amount of energy that is in the gallon of petroleum products.

You know one of the most eloquent arguments from an engineering standpoint that has ever been made is that kerosene ought to be higher priced than gasoline because there are more heat units in it. We don't care how many heat units we get in a gallon, but it is how many we can use. We don't use as many out of kerosene as out of gasoline, so it is not worth as much.

Airplane Service to Isolated Mines

Faced by impassable winter barriers isolating them during the winter season, and desiring to keep in touch with the outside world, miners in the Sierra Mountains of California have urged upon business men the establishment of an airplane line which would be an all-year-round service medium.

To test out the idea an airplane was sent over a tentative route.

With Pilot Eldredge at the wheel and carrying two passengers, the plane made a circuit of approximately 60 miles over the mining region, landing just 51 minutes from the time of starting.

Heading first for Colfax, the plane passed over the following places where mining is being conducted:

Morning Star, Iowa Hill, Birds' Flat, Little York, You Bet, Red Dog Nevada City and the Grass Valley district. Most of these places are off the railroads and on very poor roads, and it is estimated that it would require eight hours to reach them with a powerful automobile.

The cost of fuel and oil for the trip was calculated at $3.18.

It is stated that small mines are often forced to close down by reason of breakage of machinery and difficulty in getting in repairs, thus losing valuable time.

Tests for Aviators Who Lost Ratings

The Judge Advocate General of the Army has ruled that an officer holding a flying rating loses it by separation from the Air Service. Officers now in the Air Service who lost their ratings in this manner are to have opportunity to regain their ratings by heavier-than-air and lighter-than-air tests. The requirements for aviator are the passing of a test formerly known as the J. M. A. test in one service type of airplane, and qualifying in an oral examination in engines, airplanes and meteorology, and in case of failure in oral examinations a written examinaion will be required.

The test for lighter-than-air requires demonstration of ability as pilot in one or more free balloon flights, the passing of the observers' examination flights, and oral or written examination upon the ground subjects of the observers' course. Officers who have been separated from the Air Service for less than one year will be rerated without test.

There are officers now in the Air Service who, during a previous term of service therein, received flying instruction which entitled them to a flying rating, but who were never actually announced in orders as rated fliers. Such officers may submit applications for appropriate ratings upon successful completion of examinations and tests required for aviators.

The Intercollegiate Flying Association

The Intercollegiate Flying Association was formed in December, 1919, by representatives from the Aero Clubs of five colleges, for the purpose of maintaining and building up the spirit and interest of aviation among college men, and for the binding together of those fliers into a unified, organized body. Its purpose is to establish and maintain active flying clubs in every college in the United States, in order that service fliers may keep in touch with aviation and in order to build up the interest among future college men.

The idea of such a formation was first developed by the Havard Aeronautical Society and, after the plans as drawn up had been referred to several aeronautical authorities for verification, invitations were sent to the Aero Clubs in all of the eastern universities to meet for consultation in New York on December 30 and 31, 1919. On these days, delegates representing Columbia, Harvard, Princeton, Williams, and Yale met, discussed policies of organization and, on December 31, 1919, formed The Intercollegiate Flying Association. The constitution and by-laws were adopted and officers were elected.

During the meetings which followed throughout the spring of 1920, Cornell, Rutgers, Wesleyan, Lehigh, Pittsburg, and Pennsylvania were admitted to membership. The charter membership was closed and plans were drawn up for the first annual meet to be held on May 7, 1920.

The officers of the association for 1920-21 are: President, Meredith H. Pyne of Princeton, The Ivy Club, Princeton, N. J.; vice-president, E. H. Kelton of Harvard, 7 Bryant St., Cambridge, Mass.; secretary, Robert A. Curry of Columbia, Delta Tau Delta, Columbia University, New York; treasurer, Louis Dussere of Pittsburgh, 3501 Terrace Street, Pittsburgh, Pa.

The first annual meet last May was a success and the events held were: Maneuvering and acrobatics, take-offs and landings to mark, alert competition and a cross country race.

The trophies awarded and their winners were: American Flying Club Trophy—To go to the club scoring the highest number of points in the meet. Won by Yale. Aero Club of Massachusetts Trophy—To go to the club winning the cross country race. Won by Yale. Cleveland Aviation Club Trophy—To go to the Club scoring highest in events 1, 3 and 4. Won by Columbia.

An attractive booklet giving the form of application for membership and the constitution has been prepared and may be obtained by addressing the secretary.

England-Norway Airway Planned

Plans are under way for the inauguration of an air service between England and Norway, by way of Denmark and Germany. A tri-weekly service is planned for the winter months and a daily service for the summer. The *Morgenbladet* of Christiania states that an Anglo-Norwegian air traffic company has been formed at a capitalization of 300,000 kronen, of which 200,000 kronen has been subscribed in England.

The company, according to this newspaper, has already acquired a Handley Page machine with accommodation for ten passengers and two pilots. Tests between Christiania and London will be carried out early this winter, it says, and in the spring, if the tests prove the venture a success, four more planes will be purchased and a regular service opened.

The service between Bergen and Stavanger, recently opened, states The *Morgenbladet*, has been a success, despite very unfavorable weather. Five hydroairplanes are used in this service of English make and two German. Eighteen passengers are carried on each trip and a large quantity of mail matter.

Mexican Air Organization

The Secretary of Communications and Public Works of Mexico has created a new department known as Technical Aviation to study all aspects of official and commercial aviation. Juan Guillermo Villasana who has been appointed head of this department has special qualifications for this office, as in the past administration he occupied the position of director of the Bureau of Aeronautical Construction.

Aircraft Course at Columbia

At Columbia University, New York, there will be given on Monday evenings, beginning February 7, by Frank E. McKone of the Massachusetts Institute of Technology a series of lectures on "An Elementary Study of Air Navigation Problems and Aircraft."

In this course some of the fundamental principles of several important elements entering into the employment of aircraft both for war and also for special commercial purposes will receive major consideration. Engineering accomplishments and problems awaiting solution will be described. Possibly lantern slides and illustrative matter of various sorts will be used.

The course will appeal to those who desire to understand and to take some part in this new industry. Some of the topics that will receive consideration are:

I. Present economic requirements of aircraft: military and naval requirements of aircraft; postal department requirements of aircraft; private employment of aircraft; aircraft industries.

II. Nomenclature: airships, airplanes, propellers, meteorology, aero engines, locomotion by air, instruments, parachutes.

III. Aircraft, heavier than air, principles of sustentation, types of airplanes, construction of airplanes, characteristics of typical airplanes.

IV. Aircraft, lighter than air; principles of sustentation, rigid airships, non-rigid airships, construction of airships.

V. Aircraft engines: principles of the gas engine, the water-cooled gas engine.

VI. Meteorology: properties of the atmosphere, storms, weather forecasting, instruments.

Naval Aviation in South America

The Navy Department has received an interesting report from the U. S. Naval Air Station at Coco Solo, Canal Zone, concerning the enthusiasm of the business men of South America are showing in aviation. The report states that the various long distance fiights made from the air station by Navy seaplanes have attracted wide attention, and numerous requests to visit various points in South America are being received.

The last long distance flight made from Coco Solo was to Port Limon and return, a distance of 400 miles. Port Limon broadcasted by radio the start of the planes, and the planes also kept in touch by radio with the shore stations and ships all along the route. Communication with the aircraft was thus maintained throughout the trip.

Flying Boat Mail Service in Philippines

The Bureau of Insular Affairs, War Department, has purchased for the Philippine government from the Navy Department two F-5-L and three HS-2-L flying boats with four spare Liberty engines and a number of spare parts. This equipment will be used to establish an aerial mail and passenger service between Manila and the other large towns of the Philippines. The flying personnel consists of thirty Philippine National Guard officers who have been in training for about six months in a school conducted for that purpose by the Curtiss company under a contract with the Philippine government. The machines have been shipped to the Philippines and upon arrival there they will be converted for the mail and passenger service. The F-5-L types can carry thirteen and the HS-2 six passengers. It is expected that the Philippine aerial mail and passenger service will be inaugurated early this year.

Graduates from Air Service Mechanics School

During the month of October, one hundred and two students were graduated from the Air Service Mechanics School at Kelly Field; fifty-eight were graduated from the course for engine mechanics; fifteen from the course for airplane mechanics and parachute repairmen; five from the course for parachute repairmen; fourteen from the course for airplane mechanics; and ten from the course for auto repairmen. At the completion of their work, these men were sent to nineteen different Air Service stations in the United States.

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Figured on the basis of miles-per-hour to cubic inch capacity the result of this race proves that the winner had but four-sevenths of the effectiveness of the Wright-powered Thomas-Morse entry.

Again in one of the other classes, the Navy entry (a Vought) powered with a Wright Model E motor of 718 cubic inch capacity succeeded in establishing a speed of 143 miles per hour, or at the rate of .1975 miles per hour per cubic inch displacement, while the larger planes, from which the Vought won, obtained but .0862 miles per hour per cubic inch displacement. One of the most remarkable showings made in aeronautical engine design.

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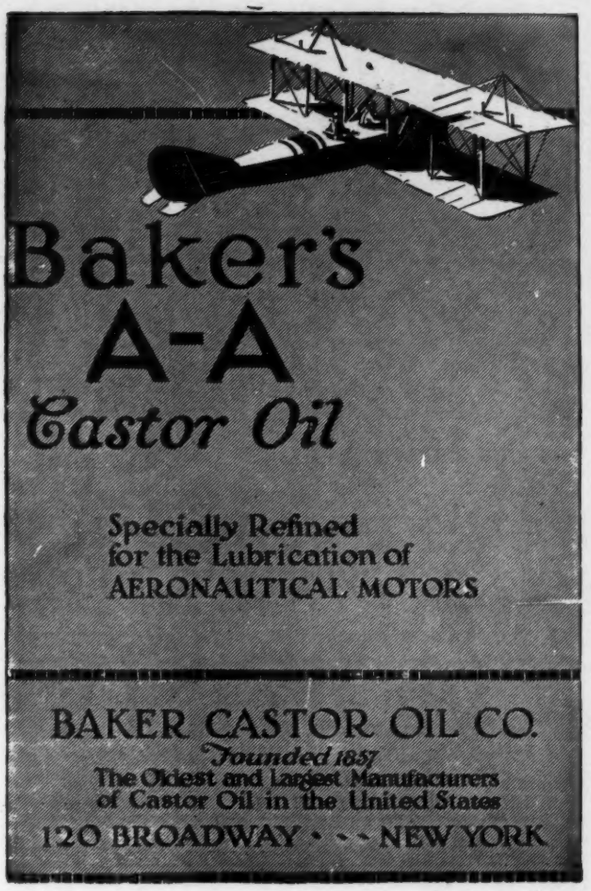

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